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# IOWA STATE COLLEGE

OF

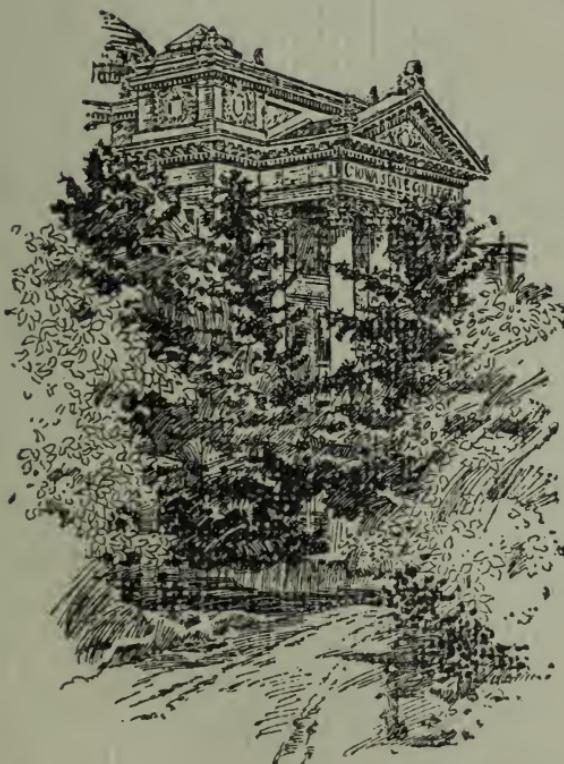
## AGRICULTURE AND MECHANIC ARTS

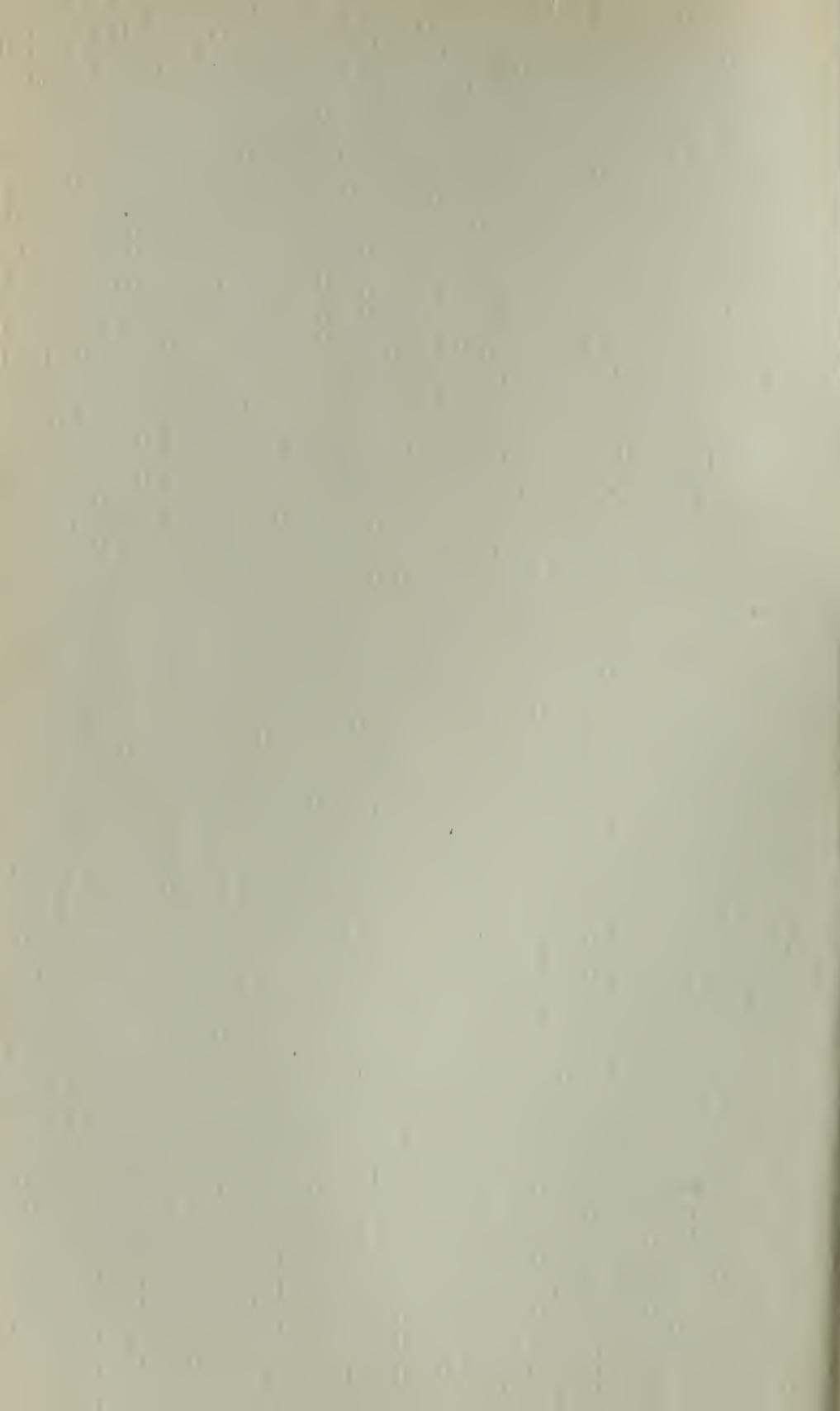
AMES, IOWA

### THE GRADUATE DIVISION

1915-1916

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OFFICIAL PUBLICATION OF  
IOWA STATE COLLEGE OF AGRICULTURE  
AND MECHANIC ARTS

Vol. 14

OCTOBER 10, 1915

No. 15

THE LIBRARY OF THE  
IOWA STATE COLLEGE OF AGRICULTURE  
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AMES, IOWA

ANNOUNCEMENT

OF THE

GRADUATE DIVISION

AMES, IOWA

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# College Calendar

1915-1916

## FIRST SEMESTER

September 10-11—Registration of graduate students.  
September 13—Instruction begins.  
November 24, 5:00 P. M.—Thanksgiving vacation begins.  
November 29, 7:40 A. M.—Vacation closes.  
December 21, 5:00 P. M.—Christmas vacation begins.  
January 3, 1916, 7:00 P. M.—Vacation closes.  
January 28, 5:00 P. M.—College work closes.

## SECOND SEMESTER

February 4-5—Registration of graduate students.  
February 7—Instruction begins.  
April 20, 5:00 P. M.—Easter vacation begins.  
April 24, 7:00 P. M.—Easter vacation closes.  
June 7—Alumni business meeting.  
June 8, 10:30 A. M.—Commencement.  
June 8, 1:00 P. M.—Alumni and faculty banquet.

## SUMMER SESSION

June 12—Summer session begins.  
September 1, 5:00 P. M.—Summer session closes.

## FIRST SEMESTER, 1916-17

September 15-16—Registration of graduate students.

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## The College

The Iowa State College of Agriculture and Mechanic Arts embraces the following divisions, and activities:

THE GRADUATE DIVISION  
THE AGRICULTURAL DIVISION  
THE ENGINEERING DIVISION  
THE INDUSTRIAL SCIENCE DIVISION  
THE HOME ECONOMICS DIVISION  
THE VETERINARY MEDICINE DIVISION  
THE AGRICULTURAL EXPERIMENT STATION  
THE ENGINEERING EXPERIMENT STATION  
THE AGRICULTURAL EXTENSION WORK  
THE ENGINEERING EXTENSION WORK  
THE SUMMER SESSION  
THE SUB-COLLEGIATE WORK  
THE SHORT COURSES

Special announcements of the different branches of the work are supplied, free of charge, on application. The general college catalogue will be sent on request.

Address, HERMAN KNAPP, Registrar,  
Ames, Iowa.

## ADMINISTRATIVE OFFICERS

The laws of the State of Iowa provide for the management and control of the State College of Agriculture and Mechanic Arts by the State Board of Education. This board consists of nine men nominated by the Governor and confirmed by the Senate. This board appoints a finance committee consisting of three men who give their entire time to the management of the four state educational institutions of Iowa, under such rules and regulations as the State Board of Education may prescribe.

## STATE BOARD OF EDUCATION

### MEMBERS

Hon. D. D. Murphy, President .....	Elkader
Hon. Frank F. Jones.....	Villisca
Hon. A. B. Funk .....	Spirit Lake
Hon. Geo. T. Baker .....	Davenport
Hon. Paul Stillman .....	Jefferson
Hon. Chas. R. Brenton .....	Dallas Center
Hon. P. K. Holbrook .....	Onawa
Hon. Edw. P. Schoentgen .....	Council Bluffs
Hon. H. M. Eicher .....	Washington

### FINANCE COMMITTEE

Hon. W. R. Boyd, President .....	Cedar Rapids
Hon. Thomas Lambert .....	Sabula
Hon. W. H. GEMMILL, Secretary .....	Des Moines

### OTHER OFFICERS

Jackson W. Bowdish, Auditor and Accountant .....	Des Moines
P. E. McClenahan, Inspector of Secondary Schools .....	Des Moines
John E. Foster, Assistant Inspector .....	Des Moines
Leslie I. Reed, Assistant Inspector .....	Des Moines

## OFFICERS OF ADMINISTRATION OF THE COLLEGE

Raymond Allen Pearson, M. S. in Agr., LL. D.....	President
Edgar Williams Stanton, M. S., LL. D.	

Vice-President, Secretary and Dean of the Junior College

Charles Franklin Curtiss, M. S. A., D. S.

Dean of the Division of Agriculture

Anson Marston, C. E.....Dean of the Division of Engineering

Charles Henry Stange, D. V. M.

Dean of the Division of Veterinary Medicine

Catharine J. MacKay .....Dean of the Division of Home Economics

R. E. Buchanan, M. S., Ph. D...Dean of the Division of Industrial Science

Herman Knapp, B. S. A.....Treasurer and Registrar

Thomas Sloss .....

Superintendent of Buildings and Grounds

Mrs. Emily Cunningham .....

Advisor for Women

The College Faculty is composed of the president, deans, professors, associate professors, heads of the extension work and the advisor for women.

# Graduate Division

PRESIDENT RAYMOND A. PEARSON, Acting Dean

## GENERAL STATEMENT

The Iowa State College of Agriculture and Mechanic Arts offers major and minor work for the degree of Master of Science in the following subjects with special application to the industries: agronomy, animal husbandry, bacteriology, botany, chemistry, dairying, economics, engineering, farm management, forestry, geology, horticulture, mathematics, physics, veterinary anatomy, veterinary pathology, veterinary physiology, and zoology. Graduate instruction leading to the degree of Doctor of Philosophy is also offered in agronomy, animal husbandry, bacteriology, botany, chemistry, dairying, geology, horticulture, and zoology. Additional minor supporting work is offered in other departments to supplement graduate study along technical lines.

## FACULTY

The president, the deans, the heads of the departments in which graduate instruction is authorized, and other members of the faculties who are in immediate charge of graduate instruction are members of the Graduate Faculty.



CAMPUS DRIVE

## ORGANIZATION

The instruction and training of graduate students has been one of the functions of the Iowa State College since its early history. The first degree of Master of Science was conferred in 1877. In 1879 the first degree of Civil Engineer and the first degree of Master of Philosophy were conferred. In early years, the department or departments in which the student was registered mapped out the applicant's course and supervised his work. Later, when the divisions of the College had been created, each division controlled its own graduate work. It was not long, however, until the number of graduate students and the diversified character of their work demanded further organization, and a Graduate Committee was appointed to supervise the work of all graduate students. This Committee was in charge until 1913 when the increase in the graduate work made it necessary to still further perfect the organization and the Graduate Division was established. The Graduate Division is administered by the President of the College as Acting Dean and the Graduate Faculty. Under this organization the graduate work to be pursued in any case is under the Acting Dean, the head of the department, and the professor in charge of the work.

## AIMS AND METHODS

This is an age of great commercial, scientific, and social interests, and these interests are demanding greater economy, specialization in science, and more humanitarianism. To meet these demands the leaders in the different lines of industry, science, and social affairs must have access to more specialized training than can be secured in four years of study. The man who would be a successful competitor as an expert in any of the different lines of agriculture, or as a skilled chemist, engineer, botanist, bacteriologist, applied economic science expert, or as a teacher or investigator in any of these subjects can by graduate training so increase his efficiency as to open up opportunities otherwise denied him. The development of scientific agriculture, engineering, manufacturing, and all the supporting sciences is dependent upon this training. A greater Iowa, economically and socially, is impossible without it. The Iowa State College has long since realized its responsibility in the further development of the many lines of research work in harmony with the industrial needs of the commonwealth.

Lectures, laboratory work, and seminar methods in which the student is in contact with his research problems are used in the development of the graduate work. The investigative work is shared by instructor and student, and the student acquires the spirit as well as the methods of productive work. To further encourage this spirit of research, provision has been made for the publication of specially meritorious work along some of the lines of investigation of which the institution has charge.

**FEES AND EXPENSES**

**Incidental and Janitor Fee:** The regular incidental and janitor fee for the semester is \$12.00, but all students who classify during the classification period, Friday and Saturday before College work begins, will be charged only \$9.00 a semester.

**Laboratory Fees:** Laboratory fees at the actual cost of breakage and usage are charged to students, the Treasurer's receipt for the fee being required before the students are admitted to laboratories. Some fees represent charges for mimeograph notes which are furnished at cost; usually when these notes are supplied no text book is required and the fee is in lieu of text book purchase. Deposits are required in some departments to cover the value of equipment loaned to students, and at the end of the term the amount is returned less deduction for loss and breakage. For the amount of the fee in any study the student should refer to the description of studies under the department in which the study is taught.

**Diploma Fee:** For the Master's, Doctor's, or Professional Degrees, \$5.00.



CAMPUS SCENE

**CLUBS AND SOCIETIES**

In the interest of research and investigation along the lines of applied science and for training in the presentation of results, several clubs and societies have been organized by the instructors and students in the different departments. Among these are the following:—

Graduate Club.

Iowa State College Branch of the

Iowa Section of American Society of Agronomy.

American Institute of Electrical Engineers.

Botanical Seminar.

Physics Seminar.

Applied Social Science Club.

Bacteriological Club.

Chemical Seminar.

### HONORARY FRATERNITIES

The following is a list of the Honorary Fraternities of Iowa State College, some of which are maintaining regular programs along lines of research work:—

Phi Lambda Upsilon.

Gamma Sigma Delta.

Phi Kappa Phi.

Omicron Nu.

Alpha Zeta.

Delta Sigma Rho.

Tau Beta Pi.

### ADMISSION AND DEGREES

Graduates of Iowa State College, as well as graduates of other colleges and universities of approved standing, are admitted to the Graduate Division. Before entering upon graduate work in any department, however, the applicant must present evidence that he has had the necessary prerequisite training that will enable him to pursue with profit the courses desired. It should be remembered, also, that admission to graduate work does not necessarily imply admission to candidacy for a degree.

Admission to candidacy for an advanced degree is obtained by presenting an application, signed by the head of the department in which the major work lies, to the Dean of the Graduate Division to be allowed to become a candidate for the proposed degree. The applicant's general education, his proposed course of study, and his preparedness for the special work sought, will be considered before admitting him to candidacy.

Graduate students who are not candidates for an advanced degree are not required to designate a major or minor subject but may elect their work with a view to their special purpose. Any course of study in the Graduate Division is open for election by such students upon the same conditions that are imposed upon those who are candidates for a degree. If at any time such special students desire to become candidates for an advanced degree, due consideration and credit will be given for work already done.

Upon initial classification the regular student must choose a major line of work. He obtains a registration card from the office of the Dean of the Graduate Division, presents this to the head of the department in which his major work is to be taken, and completes his classification in conformity with the following rules:—

1. From a minimum of 15 to maximum of 20 credit hours may be taken each semester.
2. A major subject allowed by the rules of candidacy for the degree shall be chosen; all major, minor and supporting work shall be outlined in consultation with the head of the department in which the major is taken.
3. The courses of study as outlined shall be made out in triplicate:

one shall be retained in the files of the department in which the major work is taken, one shall be filed in the office of the Dean of the Graduate Division, and one in the office of College Registrar. Each copy shall be signed by the head of the department in which the major work is taken, by the instructor who will have immediate charge of the major line of work, and by the Dean of the Graduate Division.

4. The course of study as outlined shall not be amended or changed except by the approval of the Dean of the Graduate Division, the head of the department, and the instructor in immediate charge; any such change shall be in writing and shall be filed with the original course of study.

**Note:** Any deficiency in Modern Languages should be made up immediately. See requirements in Modern Languages for advanced degrees.

The higher degrees conferred by the Iowa State College are the Master of Science and Doctor of Philosophy for advanced work in the technical fields especially developed at this college; and the Professional Degrees of Civil Engineer (C. E.), Electrical Engineer (E. E.), Mechanical Engineer (M. E.), Engineer of Mines (E. M.), Ceramic Engineer (Cer. E.), Chemical Engineer (Ch. E.), Agricultural Engineer (A. E.), and Master of Agriculture (M. Agr.).

#### REQUIREMENTS FOR MASTER'S DEGREE

The degree of Master of Science will be conferred upon students who have completed work in compliance with the following provisions and requirements:—

1. One year must be spent in resident work.
2. At least thirty credit hours or the equivalent must be completed, at least half of which should be from this institution.
3. A minimum of twenty credit hours shall be completed in the major work. Minor work is optional with the department, but it is recommended. Not more than ten hours of minor work will be credited toward the advanced degree.
4. A satisfactory reading knowledge of French or German must be certified to by the Head of the Department of Modern Languages prior to admission to examination. Upon the recommendation of the head of the department some other modern language may be substituted for French or German.
5. Only such subjects as are designated as "undergraduate and graduate" or "graduate" will be credited toward the advanced degree. Major work will ordinarily be restricted to graduate subjects.
6. Thesis is optional with the department in which the major work is taken.
7. Examination shall be taken on all graduate work including thesis when this is required. This shall be oral or written as determined by the instructors concerned.

## REQUIREMENTS FOR MASTER'S DEGREE PARTLY *IN ABSENTIA*

Any graduate of Iowa State College or other institution of high standing may be permitted to do one-half the required work for the Master's Degree *in absentia* as follows: 1. The applicant must be in residence at this institution during at least three six-weeks summer sessions. 2. During the period of two consecutive years while not in residence at the College the candidate must pursue a course of advanced study previously arranged by the head of the department in which the work is to be done and which has been approved by the Dean of the Graduate Division. This *absentia* work is expected to equal in amount that normally accomplished in three six-weeks summer sessions and is to lie along the line of his major work. Such special students are required to pass examinations on all work done at the College and *in absentia*.



ALONG SQUAW CREEK

## REQUIREMENTS FOR DOCTOR'S DEGREE

The degree of Doctor of Philosophy will be conferred upon students who complete work in compliance with the following provisions and requirements:—

1. Three years of graduate work are required, one of which must be spent at this institution. At least ninety credit hours or the equivalent shall be passed.
2. The degree will be conferred not solely as a result of a faithful

study over any period, but for ability to do research work of a scholarly character and the successful passing of all examinations.

3. Major work shall be taken in one subject, or, in exceptional cases, in two closely related subjects. Two minors shall be taken when only one major is chosen, and one minor shall be taken when two majors are chosen.

4. Minor work shall represent from one-fourth to one-third of the work for the degree.

5. One minor must be taken outside the department in which the major is taken.

6. A reading knowledge of French and German must be certified to by the Head of the Department of Modern Languages at least one year prior to final examination.

7. During the last two years of graduate work only such courses as are designated as "graduate" shall be credited on major work.

8. A thesis which is a real contribution to knowledge along some line in which the major is taken must be completed.

9. Not later than April 1st of the academic year in which the degree is sought, the candidate shall have his thesis approved by the head of the department in which the major work has been taken and submitted in typewritten form to the Dean of the Graduate Division, who shall refer it to a committee for the purpose of final approval.

10. Publication of the thesis by the candidate or by a scientific journal is required. In either case the degree will not be conferred until two type-written copies of the thesis have been deposited in the library and a financial guarantee that fifty printed copies in approved form will also be deposited in the library.

11. The Dean of the Graduate Division shall appoint for each candidate an examining committee composed of five members, including the professors in charge of the major and minor work, the chairman of which shall be the professor in charge of the student's major work. The Dean shall also designate the time and place for the examination, which may be either oral or written or both, over the fields of the major and first minor. In case a second minor is chosen, the examination over it may be waived if the candidate's standing in it is satisfactory.

### SYSTEM OF GRADING

Grades, when possible, are reported to the Registrar in per cent. When percentages are impossible, grades are reported as passed (P), or failed (F), together with the number of credit hours.

### REQUIREMENTS FOR PROFESSIONAL DEGREES

In *Engineering* the requirements may be met in any one of the three following ways:—

1. Graduation from a regular four-year course in engineering, one year of resident study approved by the engineering faculty, at least one year of experience in a responsible professional position, and the preparation of a satisfactory thesis.

2. Graduation from a regular four-year course in engineering, at

least five years of experience in a responsible professional position, and the preparation of a satisfactory thesis.

3. Graduation from a regular five-year course in engineering, at least one year of successful professional experience, and the preparation of a satisfactory thesis.

In *Agriculture* the requirements for the degree of Master of Agriculture are as follows: Graduation from a standard collegiate course in agriculture, at least five years successful experience in some phase of practical or professional agriculture, and the presentation of an acceptable thesis.

In *Agriculture and Engineering* the requirements for the degree of Agricultural Engineer are the same as those for the Professional Engineering degrees, except that the candidate must be recommended by the faculties of both the Agricultural and Engineering Divisions.

### FELLOWSHIPS AND SCHOLARSHIPS

For the promotion of educational efficiency the Board of Education has established at Iowa State College a system of fellowships and scholarships.

Scholarships are given to holders of a baccalaureate degree and carry with them a stipend of two hundred dollars payable in ten equal payments with the remission of tuition. All scholars pay laboratory fees, a two dollar hospital fee, and a fee of one dollar for each hour's work up to seven hours. Scholars are required to do three hours teaching a week or the equivalent.

Teaching Fellowships are open to graduates of reputable institutions and carry with them a stipend of four hundred dollars with the remission of tuition. Teaching Fellows are required to do five hours of teaching a week or its equivalent. The fees for Fellows are the same as those for Scholars.

Junior and Senior Research Fellowships are open to graduates of reputable institutions and have for their object the encouragement of research work. Junior Research Fellowships may be held during the first year of graduate study and carry with them a stipend of three hundred dollars with the remission of tuition. Senior Research Fellowships carry with them a stipend of five hundred dollars and are ordinarily not awarded except to those who have had at least one year of graduate study or research experience. Research Fellows in the experiment stations shall observe experiment station hours throughout the college year, except for the time given to minor work. The fees for all Fellows are the same as those for Scholars.

Full resident credit may be given for graduate work to holders of scholarships, and of teaching and research fellowships.

**NOTE:** The members of the institutional and investigational force of rank of instructor or assistant are permitted to do graduate work. Those on half time employment may receive not to exceed two-thirds time credit, and those on full time may receive not to exceed one-fourth time credit. All adjustments as to the amount of credit to be allowed shall be made between the Head of the Department in which the work is taken and the Dean of the Graduate Division.

## DEPARTMENTS OFFERING GRADUATE INSTRUCTION

### Agricultural Engineering

Professor Davidson; Associate Professor Costelloe; Assistant Professor Mervine

The department offers major work for the degree of Master of Science in Agricultural Engineering along the lines of farm machinery, farm power, drainage, irrigation, rural sanitation, and farm structures; and minor work for students selecting major work in other departments.

The equipment of the Department of Agricultural Engineering is very complete. The department occupies the two lower floors of Agricultural Engineering Hall and the Agricultural Engineering Annex and has a large garage, shops, and well equipped laboratories with the best modern farm machinery.

The farm machinery equipment includes samples of steam, gasoline, and oil tractors, one I H C auto-wagon, one Avery three-ton truck, one or more samples of most every kind of the important field and power machines. The department has several special dynamometers, the use of fourteen modern engines of different types with indicators and testing apparatus, a 750 watt gasoline-electric plant and two complete acetylene lighting plants to add to the usefulness of the laboratory.

The following studies are open to graduates:—

Farm Machinery; Farm Motors; Rural Sanitation; Farm Structures; Drainage Engineering; and Irrigation.

For the requirements for the professional degree of Agricultural Engineering see page 12.

### Agronomy

Professors Stevenson, Hughes, Brown; Associate Professor Smith; Assistant Chiefs Potter, Burnett

Graduate work in agronomy comprises investigations in the two general fields of soils and of farm crops. Major and minor work for the Master's Degree is offered along the lines of crop production, plant breeding, soil physics, soil fertility, soil bacteriology, soil humus, and soil management. For the Doctor's Degree, major and minor work is offered in soil fertility, soil bacteriology, and soil humus.

In order to register for graduate work in agronomy, a student must have obtained his baccalaureate degree from an institution of recognized standing.

The Department of Agronomy has eight commodious and well equipped soil laboratories for scientific work; suitable greenhouses and field plots for study and experimentation; and valuable data secured from extensive soil experiments; photographs, charts and maps which serve the needs of advance students.

The following studies are open to graduates:—

Special Problems in Production and Breeding of Farm Crops; Methods of Crop Investigation; Experimentation Methods and Work; Judging; Small Grain and Forage Crops; Research in Plant Breeding; Research in Crop Production; Research in Soil Physics; Research in Soil Management; Soil Bacteriology; Research in Soil Bacteriology; Research in Soil Humus.



AGRICULTURAL HALL

### Animal Husbandry

Professors Pew, Kildee, Turpin; Associate Professors Vaughn, Lloyd-Jones, Shearer, Ferrin; Assistant Chief Evvard

The department offers major and minor work for Master's Degree along the lines of animal nutrition and feeding, animal breeding, live stock management, dairy husbandry, and poultry husbandry, and major and minor work for the Doctor's Degree along the lines of nutrition and breeding.

The student who elects animal breeding as his major is expected to choose some subject for his thesis which will come under any one of the various lines of work mentioned above. This subject must be thoroughly investigated and a suitable thesis written. He must also choose a minor subject and elect supporting courses.

The equipment of the Animal Husbandry Department consists of an excellent collection of horses representing all of the market classes and breeds of both light and heavy types, among which are the Shires, Percherons, Clydesdales, Standard breeds, and American saddle horses; two hundred head of cattle, representing all of the leading beef, dual-purpose, and dairy breeds, among which are seventy representatives of the Holsteins, Jerseys, Guernseys, Ayrshires, with good sires of the different breeds; two hundred head of seven different breeds of sheep; six breeds of the best American and British varieties of swine; herd books; photographs, charts, and lantern slides; a well equipped twenty-acre poultry farm; and a two hundred acre dairy farm.

The following lines of study are open to graduates:—

Live Stock Production, Breeding, Feeding, Management, and Judging; Milk and Wool Production; Animal Nutrition; Market and Breeding Types of Poultry; and Research.

**Bacteriology and Hygiene**

Professors Buchanan, Brown; Associate Professors Murray, Hammer; Assistant Professor Levine

Major and minor work leading to the degrees of Master of Science and Doctor of Philosophy are offered in the following lines: household bacteriology and zymotechnology, general and systematic bacteriology, dairy bacteriology, sanitary bacteriology, soil bacteriology, and veterinary and pathogenic bacteriology.

The student who elects his major in any field of bacteriology should present undergraduate credits in organic chemistry, one semester of physics, the equivalent of Course 1 in Bacteriology, and an elementary course in the line in which he expects to major. Ordinarily a student must do two-thirds of his work in one of the lines of bacteriology above mentioned.

The following studies are open to graduates:—

General Bacteriology; Advanced Bacteriology; General and Pathogenic Bacteriology; Seminars; Bacteriology of Pathogens; Special Poultry Bacteriology; Immunity and Serum Therapy; Dairy Bacteriology; Research in General and Systematic Bacteriology; and Research in Dairy Bacteriology.

**Botany**

Professor Pammel; Associate Professor Martin; Assistant Professor Bakke

The student who elects botany as a major for the degree of Master of Science will be required to take as his major at least twenty credit hours from the subjects designated as "graduate." The minor work may be selected from the subjects designated as "undergraduate and graduate."

For the degree of Doctor of Philosophy the student should have all of the strictly undergraduate work in botany given elsewhere in the catalogue and at least sixty hours of major graduate work in botany covering the various lines of morphology, physiology, taxonomy, pathology, and economic botany; and minor work along the collateral lines related to botany.

The following studies are open to graduates:—

Plant Embryogeny; Botany of Weeds; Evolution of Plants; General and Experimental Morphology; Methods of Histology; Cytology and Methods of Histology; Physiology, Ecology, Agrostology; Systematic Botany; Dendrology; Mycology; Vegetable Pathology; Range and Poisonous Plants; Botanical Seminars; Cytology; Advanced course in Thallophytes; Applied Botany; Microscopical Examination of Foods; Seed Testing; Poisonous Plants; and Research.

**Ceramics**

Professor Beyer; Associate Professor Staley; Assistant Professor Galpin

The department offers major and minor work for the degree of Master of Science along the lines of ceramic technology of crude and fine clay products, the technology of glass and enamel making, the geology of clays and ceramic materials, microscopic study of clays, and ceramic materials and cement making.

The Department of Ceramics maintains a clay working laboratory equipped with up-to-date machinery; kiln rooms with both an up-and down-draft experimental kiln using solid fuel, and a pottery kiln in which



A FAMILIAR WALK

oil is burned; a drying and physical testing room with all the necessary utensils for making up and testing clays and other ceramic materials; and a gas and fuel testing room equipped with an improved Elliott apparatus for gas analysis, a Parr calorimeter for solid fuels, a Junker calorimeter for gas and oils, Le Chatelier electric, a Wanner optical, and a Brown metallic pyrometer.

The following studies are open to graduates:—

Ceramic Lectures; Ceramic Design; Special Problems; and Research in the above lines of work.

For the professional degree of Ceramic Engineer see page 12.

### Chemical Engineering

Professors Beyer, Coover; Associate Professor Gabriel

Students majoring for advanced degrees in other departments of the Engineering, Industrial Science, and Agricultural Divisions may minor in chemical engineering. At the present time the department is not offering all of the requirements for the degree of Master of Science.

The Chemical and Engineering Departments are provided with facilities for investigation of manufacturing problems and for conducting industrial research according to a practical system of coöperation between

science and industry. These facilities are open to graduate students in chemical engineering.

The following studies are open to graduates:—

Industrial Chemistry; The Chemistry of the Manufacture of Foods; Chemical Machinery; Applied Electrochemistry; Municipal Chemistry; and Research in Manufacturing Problems.

For the professional degree of Chemical Engineer see page 12.



CHEMISTRY BUILDING

### Chemistry

College Department Staff: Professor Coover; Associate Professors Fowler, Gabriel, Test, Wilkinson, Renshaw. Agricultural Experiment Station Staff: Chief Dox. Engineering Experiment Station Staff: Chief Coye.

The Chemistry Department offers major and minor work for Master's Degree along the lines of agricultural, analytical, household, industrial, applied inorganic, applied organic, applied physical, and physiological chemistry and nutrition. For the Doctor's Degree the department offers work for a minor in the above subjects, and for a major along the lines of agricultural, applied organic, applied physical, and physiological chemistry and nutrition.

The student entering upon graduate work in chemistry must have completed a course in general and inorganic chemistry, qualitative and quantitative analysis, and organic chemistry equivalent to those given in an approved college or university. He must also have completed the elementary courses given by the department along the line in which he wishes to major.

In the Agricultural Experiment Station thesis work is offered in agri-

cultural and biological chemistry. In the Engineering Experiment Station thesis work is offered in industrial chemistry and the chemistry of road materials.

The following studies are open to graduates:—

Inorganic Chemistry; Research in Applied Inorganic Chemistry; Qualitative and Quantitative Analysis; Research in Analytical Chemistry; Applied Physical Chemistry; Electro-chemistry; Research in Applied Physical Chemistry; Analysis of Carbon Compounds; Manufacture of Fine Organic Chemicals; Applied Organic Chemistry; Research in Applied Organic Chemistry; Food Analysis; Research in Food Analysis; Dairy Chemistry; Sanitary Chemistry; Agricultural Chemistry; Research in Agricultural Chemistry; Physiological Chemistry; Research in Metabolism; Industrial Chemistry; Chemical Machinery; and Municipal Chemistry.

### Civil Engineering

Professors Kirkham, King; Associate Professors Evinger, Crum, Agg

The department offers major work for the degree of Master of Science in Civil Engineering along the lines of masonry structures and experimental engineering, railway engineering, structural engineering, hydraulic and sanitary engineering, masonry design, highway engineering; and minor and supporting work in the other departments of the Engineer-



ENGINEERING HALL

ing, Agricultural, and Industrial Science Divisions. Students may therefore major in civil engineering and minor in any department of the Agricultural and Industrial Science Divisions which offers a correlated line of work, and vice versa.

The Departmental of Civil Engineering occupies nine rooms in the Engineering Hall, eight rooms in the Structural and Hydraulics Laboratory, four rooms in the Engineering Annex, and the entire Transportation Building. Included within the eleven engineering buildings there are the following laboratories and drafting rooms: the cement laboratory; the

the structural materials laboratories; the hydraulics laboratory; laboratory for testing non-bituminous road materials; the bituminous materials laboratory; and six large drafting rooms. The equipment for advanced work in these laboratories is of the best on the market and is sufficient to accommodate many graduate engineering students.

The following studies are open to graduates:—

Water Purification; Sewage Treatment and Municipal Wastes Disposal; Elements of City Planning; Seminars; Water Supply; Railway Design; Railway Operation; Advanced Structural Engineering; Road Materials; Experimental Work in Civil Engineering; Masonry Design; Highway Engineering; Roads and Pavement Design; and Railway Engineering.

For the professional degree of Civil Engineer see page 12.



DAIRY BUILDING

### Dairying

Professor Mortensen; Associate Professor Hammer; Assistant Professor Rudnick

The Dairying Department offers major work for the Master's Degree along the lines of butter making, ice cream making, factory management, and dairy bacteriology; and minor work in butter making, ice cream making, factory management, dairy bacteriology, market milk, cheese making, milk technology, testing milk and its products.

The department also offers (in correlation with the fundamental sciences) major work for the Doctor's Degree along the lines of factory management and dairy bacteriology; and minor work in butter making, ice cream making, factory management, dairy bacteriology, market milk, cheese making, milk technology, and testing milk and its products.

The Dairy Department occupies the entire four-story dairy building, which contains the different laboratories which are equipped for scientific investigation in any of the above lines of work. Graduate students seeking degrees in Dairying are supposed to be well prepared in the fundamental sciences offered in the Industrial Science Division.

The following studies are open to graduates:—

Factory Management; Fancy Ice Creams and Ices; Judging Dairy Products; Milk Testing and Inspection; Seminars; Market Milk; and Research in Dairy Bacteriology, Ice Cream Making, Butter Making, and Creamery Management.

### Economic Science

#### APPLIED ECONOMICS AND SOCIAL SCIENCE

Professor Brindley; Associate Professor Von Tungeln; Assistant Professor Ise

Major work leading to the degree of Master of Science may be taken in any of the specialized fields: agricultural economics, engineering economics, or applied sociology.

The student taking major work in applied economics and social science should take supporting work in history and psychology and in agriculture, engineering, or home economics.

The following studies are open to graduates:—

American Labor; Highway Economics; Seminars; Marketing Agricultural Products; Railway Transportation; Research in Public Utilities; State Regulation of Industries; Agricultural Credit and Applied Sociology; Rural Law; Veterinary Law; Business Law; Auditing and Accounting; Rural Statistics; Rural Sociology; Research.

### Electrical Engineering

Professor Fish; Associate Professor Bartholomew; Assistant Professors Robbins, Paine

The Department of Electrical Engineering offers opportunity for major work leading to the degree of Master of Science in Electrical Engineering. The subjects offered are advanced theory of alternating currents, electric power transmission, electric railways, and advanced work on the operating characteristics of electrical apparatus.

Opportunity for minor work is also given to those majoring in other departments of Engineering and in the departments of the Industrial Sciences and Agricultural Divisions.

The department has its offices in the Engineering Hall and the Engineering Annex. The Engineering Annex also contains the electrical laboratory with twenty-eight generators and motors of various manufacture, several transformers, over one hundred accurate instruments, mounted lamp banks, rheostats, choke coils, and other apparatus. A substation motor-generator set, which has a 100 horse-power, three-phase, 60 cycle, 1100-volt, 1200-r. p. m. induction motor takes power from the College central power plant. To one end of the motor is coupled a 60-kilowatt, 125-volt, compound wound, direct-current generator and to the other end is coupled a 50-kilowatt, three-phase, 60-cycle 220 and 110-volt alternator. The various experimental machines consist of shunt, series, interpole, and compound wound generators and motors, alternating current synchronous and induction motors, revolving field alternators, and double current generators. Individual switchboards are mounted with instruments and control apparatus for student use.

The following studies are open to graduates:—

Principles of Electrical Engineering; Direct and Alternating Current Machinery; Seminars; and advanced work in the studies above mentioned.

For the requirements for the professional degree of Electrical Engineer, see page 12.

**Farm Management**

Professor Munger; Assistant Chief Lloyd

Major and minor work leading to the Master's Degree is offered by the department in farm management, including studies of farm tenancy, cost of production and farm practice.

Students who major in this department must have a baccalaureate degree in farm management from an institution of recognized standing.

The following studies are open to graduates:—

Research in Farm Tenancy and Cost of Production; Thesis; and Seminars.



THE WILLOWS

**Forestry**

Professors Beach, MacDonald; Associate Professor Morbeck

The department offers a five year course leading to the degree of Master of Science in Forestry, and major and minor work for the Master's Degree along the lines of forest protection, forest management, lumbering, and forest products.

The student entering upon the work for an advanced degree must have completed the equivalent of the four year course in forestry.

Forestry is housed in Agricultural Hall where laboratory and class

room space is afforded. The museum contains the collection of American woods which was exhibited by Iowa at the Centennial exposition; a large collection of South American and Philippine Island woods which were on display at the Louisiana Purchase exposition; a large number of trunk specimens of trees; and about 800 lantern slides. The College has a 100-acre woods tract which serves as a demonstration area and 150 different species of trees are found on the campus.

The following studies are open to graduates:—

Advanced Forest Management; Advanced Forest Regeneration; Forestry Research; Wood Structure; Grading Lumber; and Forest Protection.

### Geology

Professor Beyer; Assistant Professor Galpin

The department offers major and minor work for the Master's Degree along the lines of mining geology, glaciology, paleontology, economic geology, and petrology. The department also offers graduate work leading to the degree of Doctor of Philosophy along the lines of economic geology and petrology.

Those who elect geology as a major for an advanced degree must have completed a course leading to the degree of Bachelor of Science in geology in a standard institution.

The museum contains several selected series of fossils, minerals, rocks and ores, from the different sections of the United States. Among these are the series of rocks collected by the United States Geological Survey; the series of rocks and minerals collected by the Smithsonian Institution; the Calvin series of paleozoic fossils; the Coastal Plain fossils from New Jersey, Alabama, Maryland and Virginia; The English mineral collection; the Permo-Carboniferous series from Kansas and Russian, and from the coal plants of Iowa, Illinois, and Pennsylvania; a large series of lead and zinc ores from the different fields in the United States; and the Dr. H. Foster Bain series of rocks and minerals.

The laboratory is equipped for scientific study in the lines in which major work is offered.

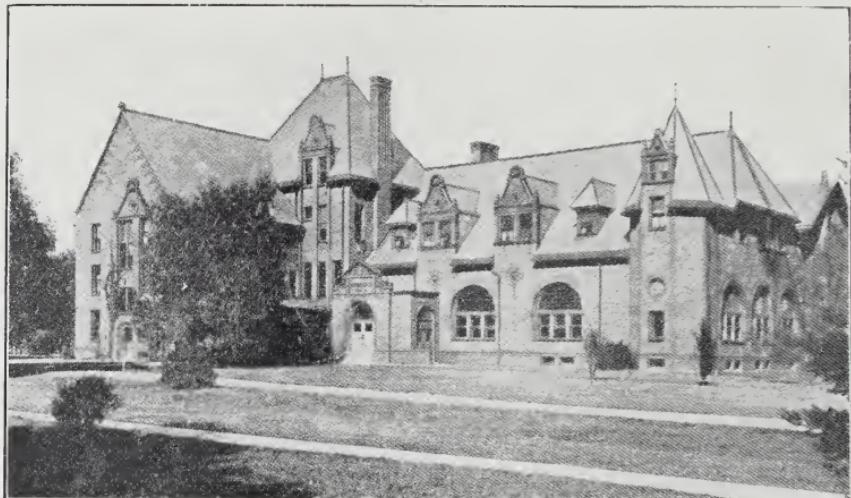
The following studies are open to graduates:—

Invertebrate and Vertebrate Paleontology; Paleo-Botany; Special Paleontology; Petrology; Optical and Physical Mineralogy; Petrography; Topographic and Geologic Mapping and Economic work; Economic Geology; Stratigraphic Geology; and Cartography.

### Home Economics

Professor MacKay; Associate Professors Russell, Gettemy, Monsch; Assistant Professor Schermerhorn

The department offers minor work for the Master's Degree along the lines of dietetics, theory of practice, sewing, and applied art. The department offers no major work for the Master's Degree, but a student with



MARGARET HALL

a major in any department of the Industrial Science Division may minor in Home Economics.

The department occupies the entire three story Home Economics Building and it has had, during the past year, nearly six hundred students.

The studies which may be chosen as minors in graduate work are:—

Nutrition and Dietetics; Theory and Practice of Teaching Home Economics; Advanced Dressmaking; Millinery; Costume and Textile Design; Home Architecture and Sanitation; and History of Art.

### Horticulture

Professor Beach; Chief Erwin; Assistant Professor Culley

The department offers major and minor work for the Master's Degree along the lines of general horticulture, pomology, truck crops, landscape gardening, and floriculture; and major and minor work for the Doctor's Degree along the lines of plant breeding and pomology.

The student who elects horticulture as his major is expected to have taken as undergraduate work the equivalent of either a pomology or a gardening course leading to the degree of Bachelor of Science in Horticulture in a standard institution.

To aid in a practical and scientific study the department has on the large campus, orchards, nurseries, vineyards, gardens and a well equipped fruiticetum. A twenty-three acre orchard and station at Council Bluffs are used by the department also. The department has a large and well equipped plant laboratory building together with new green-houses with about 30,000 feet under glass.

The following studies are open to graduates:—

Plant Breeding; Research in Plant Breeding; Fruit Farm Management; Advanced Floriculture; Market Gardening; Research in Pomology, and Truck Crops.



AT THE FOOT OF THE KNOll

### Mathematics

Professors Stanton, Roberts; Associate Professors Colpitts, Pattengill, Chaney, Snedecor; Dr. Tappan

Students who elect mathematics as major work for an advanced degree are supposed to have taken a bachelor's degree in mathematics from a recognized institution.

Major and minor work for the degree of Master of Science is offered by the Department of Mathematics. Special courses in advanced mathematics of engineering, physics, insurance and economic problems, statistics, and biological problems are offered by the department and so correlated with the technical lines of work as to demand consideration of all students who expect to teach applied mathematics in technical institutions or to become investigators in any of the above lines of work.

By special arrangements students majoring in mathematics may minor in engineering, physics, chemistry, or any of the biological sciences, if the work in such sciences is mathematical in character.

The following studies are open to graduates:—

Theory of Equations; Determinants and Advanced Analytic Geometry; Advanced Spherical Trigonometry; History of Mathematics; Advanced Differential and Integral Calculus; The Theory of Functions; Differential Equations; Projective Geometry; Higher Algebra; Infinite Series; Mathematical Theory of Statistics; Mathematics as Applied to Economic Problems; Theoretical Mechanics; Theory and Applications of Vector Analysis; Advanced Dynamics; Differential Equations of Mathematical Physics; and the Mathematical Theory of Electricity and Magnetism.

### **Mechanical Engineering**

Professor Meeker; Associate Professors Cleghorn, Major, Norman, Porter

The department offers major work for the degree of Master of Science in Mechanical Engineering along the lines of gas engineering, steam engineering, heating and ventilation, machine designing, railway mechanical engineering, automobile engineering; and minor and supporting work in the other departments of the Engineering, Agricultural, and Industrial Science Divisions.

The general offices of the department are in the Engineering Hall. The lecture and drafting and blue-print rooms are in the Engineering Hall and Engineering Annex. The department occupies the Steam and Gas Laboratory Building; the Locomotive Building; Machine Shop Building; Forge Shop Building; and the Foundry and Pattern Shop Building. The Steam and Gas Laboratory has a 150 H. P. cross compound Nordberg engine; a 535 cubic foot air compressor; a Kerr Steam Turbine connected to a 35 kilowatt, 220 volt alternating current generator; three other steam engines of various types; condensers, various types of air brakes; several types of steam and power pumps; a 50 H. P. suction gas producer and engine; four gas engines; one oil engine; a 1000 lb. refrigerating machine; all necessary small apparatus; a 50,000 lb. Olsen Testing machine; a 2,500 foot pound Olsen Torsion machine; and an American Type eight wheel locomotive given the College by the C. & N. W. Ry. Co. for testing purposes. The Machine Shop, Fore Shop, Foundry and Pattern Shop are each well equipped for scientific work.

The following studies are open to graduates:—

Mechanics of Engineering; Hydraulics; Heating Design; Machine Work; Seminars; Machine Design; Steam Engines and Boilers; Power Plant Engineering; Steam and Gas Laboratory; Crane Design; Gas Engine Construction and Operation; Gas Engine Design; Power Engineering; and Railway Mechanical Engineering.

For the requirements for the professional degree of Mechanical Engineer, see page 12.

### **Mining Engineering**

Professor Beyer; Associate Professors Hodson, Gabriel

All of the subjects offered are required of undergraduates who specialize in Mining Engineering and Metallurgy, but may be elected for minor work by graduates who are majoring along other lines. The department does not, at the present time, offer major work for an advanced degree.

The department occupies six rooms in Engineering Hall and six rooms in the Engineering Annex and Ceramics Building. The museum for geology and mining engineering is well equipped for the technical work of mining engineers. A complete Sullivan diamond drill prospecting outfit, a Water Leyner air drill, a complete set of miner's drills and tools, prospector's pans, picks, anemometers, barometers and clinometers, and mine,



ENGINEERING SHOPS

geological, and topographical maps of the most important mining districts add to the equipment. Wet and Dry metallurgical laboratories with the latest and best apparatus are maintained for all students.

The following studies are for graduates:—

Assaying; Mining Engineering; Metallurgy; and Seminars.

For the requirements for the professional degree of Engineer of Mines see page 12.

### Physics

Professor Spinney; Assistant Professors Kunerth, Plagge, Stiles, Thompson

Major and minor work leading to the degree of Master of Science is offered in heat, sound, light, illumination, electricity, magnetism, and radio-activity.

Students electing major work in Physics must hold a baccalaureate degree and present undergraduate credits for at least two year's work in mathematics and one year's work in chemistry.

The department occupies fifteen rooms in Engineering Hall and nine rooms in Engineering Annex. These rooms include nine laboratories, five class rooms and three apparatus rooms.

The Engineering Assembly, which is used as a Physics lecture room, is fitted with two lanterns, a projectoscope and screens, gas, compressed air and water connections, and electric connections to storage batteries and direct and alternating current dynamos.

The different laboratories are well equipped for scientific work.

The following studies are open to graduates:—

Laboratory-Mechanics, Heat, and Light; Advanced Course in Heat; Advanced Course in Light; Illumination; Electricity and Magnetism; Electron Theory and Radioactivity; History of Physics; Theory of Heat; Wave Motion and Sound; Theory of Light; Theory of Electricity and Magnetism; and Research.

**Structure Design**

Associate Professor Kimball

The department offers major and minor work for the degree of Master of Science along the lines of design of industrial structures, rural buildings, and the design and construction of tall office buildings.

The Department of Structure Design offers work to students who wish to study interesting problems in building construction. The work is so arranged that many different classes of buildings are studies and worked out in detail. With the facilities offered in the way of valuable library material as well as the equipment of the shops it is possible to carry out many problems in design both from the practical and theoretical standpoints. The ultimate aim of the work is to give students the opportunity to make special application of the principles learned during the under-graduate course.

The following studies are open to graduates:—

Special Interior Design; Advanced Design; Seminars; Elements of Structural Design as Applied to Agricultural Structures; Advanced Freehand Drawing; History of Structure Design; Industrial Structures; Sanitation of Buildings; and Estimating.

**Veterinary Anatomy**

Professor Murphey

Major and minor work for the degree of Master of Science are offered by the department in histology and in gross anatomy. Minor work in anatomy is suggested for students majoring in animal nutrition, biological chemistry, pathology, physiology, and zoology.



VETERINARY HALL

The student who major in anatomy for an advanced degree is expected to have had a four year course in Veterinary Medicine in a standard institution or to have had a training in anatomy and related subjects which will permit of advanced study.

The department is equipped to give instruction in the most scientific phases of anatomy to students of Veterinary Medicine or Animal Husbandry. The laboratories are all well equipped. In Histology and Osteology each student is assigned an individual desk provided with a microscope, 100 permanent mounts of tissue, laboratory notes, and one-half skeleton of disarticulated bones of the horse. A large and technically prepared list of specimens is used in the class and laboratory demonstrations.

The following studies are open to graduates:—

Osteology and Arthrology; Microscopy and Microscopic Anatomy; Myology and Splanchnology of the Horse; Microscopic Anatomy of the Organs of the Domestic Animals; Myology, Angiology, Neurology, Topography; Anatomy of Domestic Animals; Comparative Anatomy; Research in Anatomy.

### Veterinary Pathology and Bacteriology

Professor Dimock; Associate Professor Murray

The department offers major and minor work leading to the Master's Degree along the lines of systemic pathology of specific infectious diseases, pathology of sporadic diseases, tumors, chemical pathology, veterinary bacteriology, immunity and serum therapy.

The student who elects pathology for his major work must take Microscopy and Microscopic Anatomy, Microscopic Anatomy of the Organs of the Domestic Animals, General and Pathogenic Bacteriology, and General Pathology, or their equivalent. When veterinary bacteriology is chosen as major work the student must have taken General and Pathogenic Bacteriology or its equivalent.

Students who major or minor in veterinary bacteriology including immunity and serum therapy will classify with the Department of Bacteriology in the Industrial Science Division, but will do their work in the Department of Veterinary Pathology and Bacteriology.

The Department of Pathology and Bacteriology occupies the northeast building of the veterinary group. The building was planned and arranged for the work given in this department. Two offices open directly into a private laboratory which is used by the men in charge to investigate problems pertaining to their lines of work. A large general laboratory faces the north and has windows on the sides, supplying the best possible light for microscopic work. Each of the thirty individual desks in this laboratory has a plate glass top, making possible the perfect sanitary conditions necessary in handling infectious material. The desks are supplied with gas lamps, microscopes, and accessories necessary for carrying on work in both pathology and bacteriology. In connection with this laboratory there are two well equipped preparation rooms, one devoted to work in pathology and the other to work in bacteriology. The

department also has the use of a large class room which is provided with lantern slide and microscopic projection equipment.

The following studies are open to graduates:—

General Pathology; Special Pathology; Advanced Pathology; Immunity and Serum Therapy; Research in Pathology; and Research in Bacteriology.

### **Veterinary Physiology and Pharmacology**

Professor Bergman

The department offers major work for the Master's Degree along lines of investigation of physiological subjects relative to veterinary science; and minor and supporting work in physiology for graduate students in science, dairying, and annual husbandry who are doing their major work along such lines as nutrition, milk or beef production, feeding problems, breeding, etc.

The student who elects physiology as his major is expected to have taken as undergraduate work the equivalent of eight hours in Comparative Physiology together with such work in anatomy, histology, and chemistry as may be essential.

The southeast building of the Veterinary group is devoted to the work in Physiology, Pharmacy and Materia Medica, and Therapeutics. The laboratories are equipped for research work in Physiology.

The following studies are open to graduates:—

Comparative Physiology; Advanced Comparative Physiology; and Research in Physiology.

### **Zoology**

Professor Summers; Associate Professors Guthrie, Bartholomew

The department offers major and minor work for the Master's Degree along the lines of entomology, comparative physiology, invertebrate and vertebrate comparative anatomy; and major work for the Doctor's Degree along the lines of entomology and comparative physiology. Majors in any of these lines are research work.

If the student elects entomology as his major he is expected to have taken the equivalent of Advanced Entomology and Economic Entomology; if general zoology, the equivalent of General Zoology and Embryology; and if physiology, the equivalent of Embryology and Human Physiology.

The following studies are open to graduates:—

Evolution of Animals; Vertebrate Comparative Anatomy; Morphology; Advanced Invertebrate Comparative Anatomy; Advanced Entomology; Neurology; Economic Entomology; Orchard and Nursery Inspection; Literature of Entomology; and Research in Entomology.

### **DEPARTMENTS OFFERING MINOR WORK ONLY**

The work in the following departments is undergraduate in character and is subordinate and auxiliary to the work of the departments which offer major lines.

#### **Agricultural Education**

Professor Wilson; Assistant Professors Schermerhorn, Dadisman

The department offers minor work in certain fundamental courses which should be taken by one who expects to teach technical subjects.

The demand for the professional training of teachers has gradually

extended upward through the grades and high school, until now many colleges give it consideration in the selection of members of the instructional staff. Because of the evident tendency to require professional training, any graduate student who expects to teach is urged to elect work in this department as a minor if he has not already completed at least fifteen hours of such work. Students in this college who remain for a fifth year may well consider making this work one of the lines to be followed.

The studies open, as minors only, to graduates are:—

Educational History; Vocational Education; School Administration; Methods and Practice Teaching; and Research in Education.

### Agricultural Journalism

Professor Beckman; Assistant Professor Conybeare

Graduate students may minor in this department, taking work in any of the subjects offered to undergraduates. The instruction is designed to give students facility in contributing to agricultural and other technical journals.

The studies open, as minors only, to graduates are:—

Agricultural, Home Economics, and Engineering Journalism; and Agricultural Publicity.

### History

Professor Cessna; Associate Professor Schmidt

Students majoring for advanced degrees in agriculture or industrial science or applied economics and social science may minor in history by taking certain studies open to undergraduates. The chief purpose of this work is to furnish an historical foundation for the study of the present day economic and social problems in technical fields. The new trend in historical science has brought the study of history into a very fundamental relation to the industrial sciences.

The following studies, as minors only, are open to graduates:—

Economic History of American Agriculture; Industrial History of England; History of Immigration to the United States; Iowa History; History of Transportation in the United States; History of the United States as a World Power; and Industrial History of the United States, 1860-1880.

### Psychology

Professor Cessna; Assistant Professor Vance

Students majoring for advanced degrees in agriculture or industrial science or applied economics and social science may minor in psychology. It is evident that all subjects involving the human element must be based on the knowledge of the laws of mental action. The study of psychology is regarded as necessary to the proper understanding of industrial development and efficiency.

The following studies, as minors only, are open to graduates:—

Ethics; Social Psychology; Psychology of Childhood and Adolescence; Educational Psychology; Psychology of Business; The Animal Mind; and Physical and Mental Tests.



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Beach

IOWA STATE COLLEGE  
OF  
AGRICULTURE AND MECHANIC ARTS  
AMES, IOWA

THE GRADUATE DIVISION

1916-1917





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ANNOUNCEMENT

OF THE  
GRADUATE DIVISION

AMES, IOWA

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## The College

The Iowa State College of Agriculture and Mechanic Arts conducts work along five major lines:

AGRICULTURE  
ENGINEERING  
HOME ECONOMICS  
INDUSTRIAL SCIENCE  
VETERINARY MEDICINE

The Graduate Division conducts advanced research and instruction in all these five lines.

Four, five, and six year collegiate courses are offered in different divisions of the College. Non-collegiate courses are offered in agriculture, engineering, and home economics. Summer Sessions include graduate, collegiate, and non-collegiate work. Short courses are offered in the winter.

Extension courses are conducted at various points throughout the state.

Research work is conducted in the Agricultural and Engineering Experiment Stations and in the Veterinary Research Laboratory.

Special announcements of the different branches of the work are supplied, free of charge, on application. The general college catalogue will be sent on request.

Address HERMAN KNAPP, Registrar,  
Ames, Iowa.

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## ADMINISTRATION

The laws of the State of Iowa provide for the management and control of the State College of Agriculture and Mechanic Arts by the State Board of Education. This board consists of nine men nominated by the Governor and confirmed by the Senate. This board appoints a finance committee consisting of three men who give their entire time to the management of the four state educational institutions of Iowa, under such rules and regulations as the State Board of Education may prescribe.

## STATE BOARD OF EDUCATION

### MEMBERS

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John E. Foster, Assistant Inspector.....	Des Moines
Leslie I. Reed, Assistant Inspector.....	Des Moines

## OFFICERS OF ADMINISTRATION OF THE COLLEGE

Raymond Allen Pearson, M. S. in Agr., LL. D.....	President
Edgar Williams Stanton, M. S., LL. D.	

Charles Franklin Curtiss, M. S. A., D. S.	Vice-President, Secretary, and Dean of the Junior College
---	---

Anson Marston, C. E.....	Dean of the Division of Agriculture
Charles Henry Stange, D. V. M.	Dean of the Division of Engineering

Catharine J. MacKay.....	Dean of the Division of Veterinary Medicine
R. E. Buchanan, M. S., Ph. D...	Dean of the Division of Home Economics
Herman Knapp, B. S. A.....	Dean of the Division of Industrial Science
Thomas Sloss.....	Treasurer and Registrar
Mrs. Emily Cunningham.....	Superintendent of Buildings and Grounds
	Advisor for Women

# College Calendar

1916-1917

## FIRST SEMESTER

September 7-8—Entrance examinations.  
September 11-12—Registration of graduate students.  
September 13—Lectures begin.  
September 16—Y. W. C. A. and Y. M. C. A. reception.  
November ~~30~~ ~~12:00~~ m.—Thanksgiving vacation ~~begins~~.  
~~December 4, 7:10 a. m.~~ Vacation closes.  
December 2~~0~~ 12:00 m.—Christmas vacation begins.  
January 2, 12:00 m.—Vacation closes.  
January 26, 12:00 m.—First semester closes.

## SECOND SEMESTER

February 1-2—Entrance examinations.  
February 5-6—Registration of graduate students.  
February 7—Lectures begin.  
February 10—Y. W. C. A. and Y. M. C. A. reception.  
April 5, 12:00 m.—Easter vacation begins.  
April 9, 5:00 p. m.—Easter vacation closes.  
June 3, 10:30 a. m.—Baccalaureate sermon.  
June 5, 9:30 a. m.—Alumni business meeting.  
June 6, 1:00 p. m.—Alumni, faculty, senior, banquet.  
June 7, 10:30 a. m.—Commencement.

## SUMMER SESSION

June 11—Summer session begins.  
August 30—Summer session closes.

1917-1918

## FIRST SEMESTER

September 6-7—Entrance examinations.  
September 10-11—Registration of graduate students.

# \*Officers of Administration and Instruction of The Graduate Division

## President and Deans

Raymond Allen Pearson. 1912.....President  
B. S. in Agr., Cornell University, 1894; M. S. in Agr., 1899; LL. D.,  
Alfred University, 1909.

Edgar Williams Stanton. \*\*1877, 1873.....Vice-President, Dean of the  
Junior College, Professor of Mathematics  
B. Sc., Iowa State College, 1872; M. Sc., 1887; LL. D., Coe College,  
1904.

Charles Franklin Curtiss. 1897, 1891.....Dean of the Division of  
Agriculture, Director of Experiment Station  
B. S. A., Iowa State College, 1887; M. S. A., 1892; D. S. in Agri-  
culture, Michigan Agricultural College, 1907.

Anson Marston. 1892....Dean of the Division of Engineering, Professor  
C. E., Cornell University, 1899. of Civil Engineering

Charles Henry Stange. 1909, 1907....Dean of the Division of Veterinary  
Medicine, Professor of Veterinary Theory and Practice  
D. V. M., Iowa State College, 1907.

Robert Earle Buchanan. 1909-1904....Dean of the Division of Industrial  
Science, Professor of Bacteriology  
B. S., Iowa State College, 1904; M. S., 1906; Ph. D., Chicago Uni-  
versity, 1908.

Catharine J. MacKay. 1911, 1910.....Dean of the Division of Home  
Economics, Professor of Home Economics  
Diploma, Drexel Institute, 1907; Boston Cooking School, 1907; Teach-  
ers' College, Columbia University, 1910, 1914.

## Professors

Spencer Ambrose Beach. 1905.....Vice-Dean of the Division of  
Agriculture, Professor of Horticulture  
B. S. A., Iowa State College, 1887; M. S., 1892.

Harold Edward Bemis. 1913, 1908.....Vice-Dean of the Division of  
Veterinary Medicine, Professor of Veterinary Surgery  
D. V. M., Iowa State College, 1908.

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\* The Graduate Faculty is composed of the president, deans, heads of departments in which graduate instruction is authorized, and other members of the faculties who are in charge of graduate instruction.

Samuel Walker Beyer. 1898, 1891....Vice-Dean of the Division of Engineering. Professor of Geology and Mining Engineering  
B. S., Iowa State College, 1889; Ph. D., Johns Hopkins Univ., 1895.

John Edwin Brindley. 1913, 1907.....Professor of Economics  
B. L., University of Wisconsin, 1902; A. M., 1906; Ph. D., University of Iowa, 1911.

Percy Edgar Brown. 1914, 1910.....Professor of Soil Bacteriology  
B. Sc., Rutgers College, 1906; A. M., 1909; Ph. D., 1912.

Orange Howard Cessna. 1900.....Professor of History and Psychology  
B. S., Iowa State College, 1872; B. D., Garrett Biblical Institute, 1885;  
D. D., 1900; A. M., Cornell College, 1901.

Winfred Forest Coover. 1913, 1914.....Professor of Chemistry  
A. B., Otterbein University, 1900; A. M., Ohio State University, 1903.

William Wallace Dimock. 1911, 1909.....Professor of Veterinary Pathology and Bacteriology  
B. Agr., Connecticut Agricultural College, 1901; D. V. M., Cornell University, 1905; D. V. M., University of Habana, 1907.

Fred Alan Fish. 1907, 1905.....Professor of Electrical Engineering  
M. E. in E. E., Ohio State University, 1898.

Harald De Mott Hughes. 1910.....Professor of Farm Crops  
B. S., University of Illinois, 1907; M. S. A., Univ. of Missouri, 1908.

Henry Herbert Kildee. 1914, 1910.....Professor of Dairy Husbandry  
B. S. A., Iowa State College, 1908.

Gilmour Beyers MacDonald. 1913, 1910.....Professor of Forestry  
B. S. F., University of Nebraska, 1907; M. F., 1914.

Warren H. Meeker. 1907, 1891.....Professor of Mechanical Engineering  
M. E., Cornell University, 1891.

Martin Mortensen. 1909.....Professor of Dairying  
B. S. A., Iowa State College, 1909.

Harlan Bruce Munger. 1914.....Professor of Farm Management  
B. S., Cornell University, 1912.

Howard Sylvester Murphey. 1913, 1909.....Professor of Veterinary Anatomy and Histology  
D. V. M., Ohio State University, 1908.

Louis Hermann Pammel. 1889.....Professor of Botany  
B. Agr., University of Wisconsin, 1885; M. S., 1889; Ph. D., Washington University, St. Louis, 1898.

William Harper Pew. 1912, 1909.....Professor of Animal Husbandry  
B. S. A., Iowa State College, 1907.

Maria M. Roberts. 1913, 1891.. Vice-Dean of the Junior College, Professor of Mathematics  
B. L., Iowa State College, 1890.

Louis Bevier Spinney. 1897, 1891.....Professor of Physics  
B. M. E., Iowa State College, 1892; B. S. (E. E.), 1893.

William Henry Stevenson. 1903, 1902.....Professor of Agronomy, Vice-Director of Experiment Station  
A. B., Illinois College, 1893; B. S. A., Iowa State College, 1905.

Guy Mitchell Wilson. 1913.....Professor of Agricultural Education  
A. B., Indiana University, 1900; M. A., 1908.

**Associate Professors**

Henry Dale Bergman. 1913, 1910.....Associate Professor of Veterinary  
D. V. M., Iowa State College, 1910. Physiology and Pharmacology

George Arthur Chaney. 1914, 1913...Associate Professor of Mathematics  
M. S., Highland Park College, 1906; M. A., Univ. of Wisconsin, 1910.

Julia Trueman Colpitts. 1913, 1900..Associate Professor of Mathematics  
A. B., Mount Allison University, Canada, 1899; A. M., Cornell Uni-  
versity, 1900.

Martin Francis Paul Costelloe. 1912, 1911...Associate Professor of Agri-  
B. S. in C. E., University of Nebraska, 1906. cultural Engineering

Chester Charles Fowler. 1913, 1909....Associate Professor of Chemistry  
B. S. in Chem. Eng., University of Illinois, 1909; M. S., 1913; Ph. D.,  
Jefferson Medical College, 1915.

Joseph Edward Guthrie. 1913, 1902.....Associate Professor of Zoology  
B. S., University of Minnesota, 1900; M. S., 1901.

Bernard Wernick Hammer. 1913, 1911.....Associate Professor of Dairy  
B. S. A., University of Wisconsin, 1908. Bacteriology

John Owen Rankin. 1916.....Associate Professor of Economic Science  
A. B., Tarkio College, 1904; B. S. A., Iowa State College, 1908; A. M.,  
George Washington University, 1912.

Orren Lloyd-Jones. 1914, 1913..Associate Professor of Animal Husbandry  
B. S., University of Wisconsin, 1908; M. S., 1911; Ph. D., 1913.

John Nathan Martin 1912, 1911.....Associate Professor of Botany  
A. B., Indiana University, 1907; Ph. D., University of Chicago, 1913.

Charles Murray. 1913, 1908....Associate Professor of Veterinary Path-  
ology and Bacteriology  
Pe. B., Drake University, 1906; B. S., Iowa State College, 1910;  
D. V. M., 1912.

Raemer R. Renshaw. 1914, 1913...Assoc. Professor of Organic Chemistry  
B. S., University of Oregon, 1902; M. S., 1903; Ph. D., Columbia  
University, 1907.

Louis Bernard Schmidt. 1911, 1906.....Associate Professor of History  
Ph. B., Cornell College, 1901; A. M., 1906.

Roy Eugene Smith. 1914, 1909.....Associate Professor of Soils  
B. S. A., Iowa State College, 1909; M. S., 1911.

Homer Francis Staley. 1914..Associate Professor of Mining Engineering  
B. A., Ohio State University, 1904.

Louis Agassiz Test. 1914, 1913.....Associate Professor of Chemistry  
B. M. E., Purdue University, 1894; A. C., 1896; Ph. D., University of  
Chicago, 1907.

George Henry Von Tungeln. 1914, 1913..Assoc. Prof. of Rural Sociology  
Ph. B., Central Westleyan College, 1909; M. A., Northwestern Uni-  
versity, 1910.

John Anderson Wilkinson. 1914, 1913....Associate Professor of Physical  
Chemistry and Inorganic Analysis  
B. Sc., Ohio State University, 1903; Ph. D., Cornell University, 1909.

**Assistant Professors**

Henry Ellsworth Ewing. 1914.....Entomology  
B. A., University of Illinois, 1906; M. A., University of Illinois, 1908;  
Ph. D., Cornell University, 1911.

Max Levine. 1914, 1913.....Bacteriology and Hygiene  
B. Sc., Massachusetts Institute of Technology, 1912.

**AGRICULTURAL EXPERIMENT STATION**

Arthur Wayland Dox, B. S., A. M., Ph. D.....Chief in Chemistry  
A. T. Erwin, M. S.....Chief in Truck Crops  
John Marcus Evvard, M. S.....Assistant Chief in Animal Husbandry  
Orson Gunnell Lloyd, B. S., M. S....Assistant Chief in Farm Management

# Graduate Division

PRESIDENT RAYMOND A. PEARSON, Acting Dean

## GENERAL STATEMENT

The Iowa State College of Agriculture and Mechanic Arts offers major and minor work for the degree of Master of Science in the following subjects with special application to the industries: agronomy, animal husbandry, bacteriology, botany, chemistry, dairying, economics, engineering, farm management, forestry, geology, horticulture, mathematics, physics, veterinary anatomy, veterinary pathology, veterinary physiology, and zoology. Graduate instruction leading to the degree of Doctor of Philosophy is also offered in agronomy, animal husbandry, bacteriology, botany, chemistry, dairying, geology, horticulture, and zoology. Additional minor supporting work is offered in other departments to supplement graduate study along technical lines.

## FACULTY

The president, the deans, the heads of the departments in which graduate instruction is authorized, and other members of the faculties who are in immediate charge of graduate instruction are members of the Graduate Faculty.

## ORGANIZATION

The instruction and training of graduate students has been one of the functions of the Iowa State College since its early history. The first degree of Master of Science was conferred in 1877. In 1879 the first degree of Civil Engineer and the first degree of Master of Philosophy were conferred. In early years, the department or departments in which the student was registered mapped out the applicant's course and supervised his work. Later, when the divisions of the College had been created, each division controlled its own graduate work. It was not long, however, until the number of graduate students and the diversified character of their work demanded further organization, and a Graduate Committee was appointed to supervise the work of all graduate students. This Committee was in charge until 1913 when the increase in the graduate work made it necessary to still further perfect the organization and the Graduate Division was established. The Graduate Division is administered by the President of the College as Acting Dean and the Graduate Faculty. Under this organization the graduate work to be pursued in any case is under the Acting Dean, the head of the department, and the professor in charge of the work.

## AIMS AND METHODS

This is an age of great commercial, scientific, and social interests, and these interests are demanding greater economy, specialization in science, and more humanitarianism. To meet these demands the leaders in the different lines of industry, science, and social affairs must have access to more specialized training than can be secured in four years of study. The man who would be a successful competitor as an expert in any of the different lines of agriculture, or as a skilled chemist, engineer, botanist, bacteriologist, applied economic science expert, or as a teacher or investigator in any of these subjects can by graduate training so increase his efficiency as to open up opportunities otherwise denied him. The development of scientific agriculture, engineering, manufacturing, and all the supporting sciences is dependent upon this training. A greater Iowa, economically and socially, is impossible without it. The Iowa State College has long since realized its responsibility in the further development of the many lines of research work in harmony with the industrial needs of the commonwealth.

Lectures, laboratory work, and seminar methods in which the student is in contact with his research problems are used in the development of the graduate work. The investigative work is shared by instructor and student, and the student acquires the spirit as well as the methods of productive work. To further encourage this spirit of research, provision has been made for the publication of specially meritorious work along some of the lines of investigation of which the institution has charge.

## FEES AND EXPENSES

**Incidental and Janitor Fee:** The regular incidental and janitor fee for the semester is \$12.00, but all students who classify during the classification period, Friday and Saturday before College work begins, will be charged only \$9.00 a semester. Graduate scholars and fellows are required to pay a two dollar hospital fee, a fee of one dollar for each hour's work up to seven hours, and laboratory fees in their minor only.

**Laboratory Fees:** Laboratory fees at the actual cost of breakage and usage are charged to students, the Treasurer's receipt for the fee being required before the students are admitted to laboratories. Some fees represent charges for mimeograph notes which are furnished at cost; usually when these notes are supplied no text book is required and the fee is in lieu of text book purchase. Deposits are required in some departments to cover the value of equipment loaned to students, and at the end of the term the amount is returned less deduction for loss and breakage. For the amount of the fee in any study the student should refer to the description of studies under the department in which the study is taught. Scholars and fellows are exempt from laboratory fees in their major work.

**Diploma Fee:** For the Master's, Doctor's, or Professional Degrees, \$5.00. This does not include the cost of the Master's or Doctor's hood.

**CLUBS AND SOCIETIES**

In the interest of research and investigation along the lines of applied science and for training in the presentation of results, several clubs and societies have been organized by the instructors and students in the different departments. Among these are the following:

Graduate Club.	I. S. C. Branch of the American Society of Agricultural Engineers.
Iowa Section of American Society of Agronomy.	I. S. C. Branch of the American Institute of Electrical Engineers.
Botany Seminar.	Chemistry Seminar.
Physics Seminar.	I. S. C. Branch of the American Institute of Mining Engineers.
Applied Social Science Club.	Civil Engineering Society.
Mathematics Colloquium.	
Bacteriology Seminar.	

**HONORARY FRATERNITIES**

The following is a list of the Honorary Fraternities of Iowa State College, some of which are maintaining regular programs along lines of research work:

Phi Lambda Upsilon.	Gamma Sigma Delta.
Phi Kappa Phi.	Omicron Nu.
Alpha Zeta.	Delta Sigma Rho.
Tau Beta Pi.	

**ADMISSION**

Graduates of Iowa State College, as well as graduates of other colleges and universities of approved standing, are admitted to the Graduate Division. Before entering upon graduate work in any department, however, the applicant must present evidence that he has had the necessary prerequisite training that will enable him to pursue with profit the courses desired. It should be remembered, also, that admission to graduate work does not necessarily imply admission to candidacy for a degree.

Graduate students wishing to become candidates for the Master's or Doctor's degree will make application in writing to the Dean of the Graduate Division not later than February 1 of the year in which the degree is sought. This application should be approved and signed by the head of the department in which the major subject is offered and by all other members of the faculty under whom the student has done work in support of his candidacy. If the applicant has completed any graduate work in another institution, an authorized statement of the same should be filed with the application for candidacy for degree.

For purposes of admission to the Graduate Division an approved college or university is one which requires four years' work of collegiate grade for graduation, based upon an entrance requirement of at least fourteen standard high school units.

A candidate for admission should secure an application blank from the Registrar or Dean (preferably in advance). This blank should be properly filled out and returned. When the application is approved the Registrar will issue a permit to enroll. Upon the payment of fees the candidate is given a receipt which he presents to the Dean, who is the classifying officer.

Registration should be on regular classifications days to avoid payment of extra fee and it should be completed within two weeks after the opening of a semester to receive full credit for the semester's work.

## CLASSIFICATION

The classification of all *regular* graduate students must be completed in conformity with the following rules:

1. From a minimum of 15 to a maximum of 20 credit hours may be taken each semester.

2. A major subject allowed by the rules of candidacy for a degree shall be chosen; all major, minor and supporting work shall be outlined in consultation with the head of the department in which the major is taken.

3. Unless otherwise specially permitted a graduate student shall carry at least one study of strictly graduate grade each semester. In any case at least four hours of strictly graduate work must be completed each year.

4. The course of study as outlined shall not be amended or changed except by the approval of the Dean of the Graduate Division, and any such change shall be in writing and shall be filed with the original course of study.

5. In special cases a *limited* amount of credit may be given in subjects not catalogued as graduate studies where these are taken as a minor and bear directly upon the major subject and are recommended by the professor in charge of the major work and approved by the Dean.

6. Graduate students who are not candidates for an advanced degree are not required to designate a major or a minor subject but may elect their work with a view to their special purpose. Any course of study in the Graduate Division is open for election by such students upon the same conditions that are imposed upon those who are candidates for a degree. If at any time such special students desire to become candidates for an advanced degree, due consideration and credit will be given for work already done.

NOTE: Any deficiency in Modern Language should be made up immediately. See requirements in Modern Language for advanced degrees.

## DEGREES

The higher degrees conferred by the Iowa State College are the Master of Science and Doctor of Philosophy for advanced work in the technical fields especially developed at this college; and the Professional Degrees of Civil Engineer (C. E.), Electrical Engineer (E. E.), Mechanical Engineer (M. E.), Engineer of Mines (E. M.), Ceramic Engineer (Cer. E.), Chem-

ical Engineer (Ch. E.), Agricultural Engineer (A. E.), and Master of Agriculture (M. Agr.).

### **REQUIREMENTS FOR MASTER'S DEGREE**

The degree of Master of Science may be conferred upon students who have completed work in compliance with the following provisions and requirements:

1. At least one year must be spent in resident work.
2. At least thirty credit hours or the equivalent must be completed, at least half of which should be from this institution.
3. A minimum of twenty credit hours shall be completed in the major work, and a maximum of ten credit hours in the minor work. The minor work may be taken in the same department in which the major is taken, but both major and minor may not be taken under the same instructor.
4. A satisfactory reading knowledge of French or German must be certified to by the Head of the Department of Modern Languages prior to admission to examination. Upon the recommendation of the head of the department some other modern language may be substituted for French or German.
5. Such subjects as are designated as "undergraduate and graduate" or "graduate" will be credited toward the advanced degree. Major work will ordinarily be restricted to graduate subjects. See 5 under Classification.
6. Thesis is optional with the department in which the major work is taken.
7. Examination shall be taken on all graduate work including thesis when this is required. This shall be oral or written as determined by the instructors concerned.

### **REQUIREMENTS FOR MASTER'S DEGREE PARTLY IN ABSENTIA**

Any graduate of Iowa State College or other institution of high standing may be permitted to do one-half the required work for the Master's Degree *in absentia* as follows: 1. The applicant must be in residence at this institution during at least three six-weeks summer sessions. 2. During the period of two consecutive years while not in residence at the College the candidate must pursue a course of advanced study previously arranged by the head of the department in which the work is done and which has been approved by the Dean of the Graduate Division. This *absentia* work is expected to equal in amount that normally accomplished in three six-weeks summer sessions and is to lie along the line of his major work. Such special students are required to pass examinations on all work done at the College and *in absentia*.

**ADVANCED STANDING**

Graduate students of approved colleges and universities who have completed a portion of the requirements for the Master's or Doctor's degree in the technical lines developed at this institution, may be permitted to enroll as graduate students and finish their work for the desired degree. For the Master's degree at least one year of residence will be required, in which not less than fifteen credit hours of graduate work must be completed. For the Doctor's degree at least one year of residence will be required, in which not less than thirty hours of graduate work, inclusive of dissertation, must be completed.

**REQUIREMENTS FOR DOCTOR'S DEGREE**

The degree of Doctor of Philosophy may be conferred upon students who complete work in compliance with the following provisions and requirements:

1. Three years of graduate work are required, one of which must be spent at this institution.
2. The degree will be conferred not solely as a result of a faithful study over any period, but for ability to do research work of a scholarly character and the successful passing of all examinations.
3. Major work shall be taken in one subject, or, in exceptional cases, in two closely related subjects. Two minors shall be taken when only one major is chosen, and one minor shall be taken when two majors are chosen.
4. Minor work shall represent from one-fourth to one-third of the work for the degree.
5. One minor must be taken outside the department in which the major is taken.
6. A reading knowledge of French and German must be certified to by the Head of the Department of Modern Languages at least one year prior to final examination.
7. During the last two years of graduate work only such courses as are designated as "graduate" shall be credited on major work.
8. A thesis which is a real contribution to knowledge along some line in which the major is taken must be completed. The student should consult the Dean of the Graduate Division for information regarding the form in which the thesis must be presented.
9. Not later than April 1st of the academic year in which the degree is sought, the candidate shall have his thesis approved by the head of the department in which the major work has been taken and submitted in type-written form to the Dean of the Graduate Division, who shall refer it to a committee for the purpose of final approval.
10. Publication of the thesis by the candidate or by a scientific journal is required. In either case the degree will not be conferred until two type-

written copies of the thesis have been deposited in the library and a financial guarantee that fifty printed copies in approved form will also be deposited in the library.

11. The Dean of the Graduate Division shall appoint for each candidate an examining committee composed of five members, including the professors in charge of the major and minor work, the chairman of which shall be the professor in charge of the student's major work. The Dean shall also designate the time and place for the examination, which may be either oral or written or both, over the fields of the major and first minor. In case a second minor is chosen, the examination over it may be waived if the candidate's standing in it is satisfactory.

### REQUIREMENTS FOR PROFESSIONAL DEGREES

In *Engineering* the requirements may be met in any one of the three following ways:

1. Graduation from a regular four-year course in engineering, one year of resident study approved by the engineering faculty, at least one year of experience in a responsible professional position, and the preparation of a satisfactory thesis.
2. Graduation from a regular four-year course in engineering, at least five years of experience in a responsible professional position, and the preparation of a satisfactory thesis.
3. Graduation from a regular five-year course in engineering, at least one year of successful professional experience, and the preparation of a satisfactory thesis.

The professional degree of Master of Agriculture may be granted by this institution upon the completion of a standard collegiate course in agriculture followed by not less than five years of eminently successful experience in some phase of practical or professional agriculture and the presentation of an acceptable thesis.

In *Agriculture and Engineering* the requirements for the degree of Agricultural Engineer are the same as those for the Professional Engineering degrees, except that the candidate must be recommended by the faculties of both the Agricultural and Engineering Divisions.

### FELLOWSHIPS AND SCHOLARSHIPS

For the promotion of graduate and research work the Board of Education has established at Iowa State College a system of fellowships and scholarships.

Scholarships are given to holders of a baccalaureate degree and carry with them a stipend of two hundred dollars payable in ten equal payments with the remission of tuition. All scholars pay a two dollar hospital fee, a fee of one dollar for each hour's work up to seven hours, and laboratory fees in their minor subjects only. Scholars are required to do three hours teaching a week or the equivalent.

Teaching Fellowships are open to graduates of reputable institutions and carry with them a stipend of four hundred dollars with the remission of tuition. Teaching Fellows are required to do five hours of teaching a week or its equivalent. The fees for Fellows are the same as those for Scholars.

Junior and Senior Research Fellowships are open to graduates of reputable institutions and have for their object the encouragement of research work. Junior Research Fellowships may be held during the first year of graduate study and carry with them a stipend of three hundred dollars with the remission of tuition. Senior Research Fellowships carry with them a stipend of five hundred dollars and are ordinarily not awarded except to those who have had at least one year of graduate study or research experience. Research Fellows in the experiment stations shall observe experiment station hours throughout the college year, except for the time given to minor work. The fees for all Fellows are the same as those for Scholars.

Full resident credit may be given for graduate work to holders of scholarships, and of teaching and research fellowships.

**NOTE:** The members of the instructional and investigational force of rank of instructor or assistant are permitted to do graduate work. Those on half time employment may receive not to exceed two-thirds time credit, and those on full time may receive not to exceed one-fourth time credit. All adjustments as to the amount of credit to be allowed shall be made between the Head of the Department in which the work is taken and the Dean of the Graduate Division.

## DEPARTMENTS OFFERING GRADUATE INSTRUCTION

### **Agricultural Engineering**

Associate Professor Costelloe; Associate Professor Mervine; Assistant Professor Lehman

The department offers major work for the degree of Master of Science in Agricultural Engineering along the lines of farm machinery, farm power, drainage, irrigation, rural sanitation, and farm structures; and minor work for students selecting major work in other departments.

The equipment of the Department of Agricultural Engineering is very complete. The department occupies the greater part of Agricultural Engineering Hall and the Agricultural Engineering Annex and has a large garage, shops, and well equipped laboratories with the best modern farm machinery.

The farm machinery equipment includes samples of steam, gasoline, and oil tractors, one I H C auto-wagon, one Avery three-ton truck, one or more samples of most every kind of the important field and power machines. The department has several special dynamometers, the use of eighteen modern engines of different types with indicators and testing apparatus, a 750 watt gasoline-electric plant and two complete acetylene lighting plants to add to the usefulness of the laboratory.

The Agricultural Engineering Society, composed of teachers and ad-

vanced students, meets once each week for the discussion of special problems and recent developments in Agricultural Engineering.

The following studies are open to graduates:

Farm Machinery; Farm Motors; Rural Sanitation; Farm Structures; Drainage Engineering; and Irrigation. See page 92 General Catalog.

For the requirements for the professional degree of Agricultural Engineering see page 16.

### Agronomy

Professors Stevenson, Hughes, Brown; Associate Professor Smith; Chief Burnett; Assistant Chief Potter

Graduate work in agronomy comprises investigations in the two general fields of soils and of farm crops. Major and minor work for the Master's degree is offered along the lines of crop production, plant breeding, soil physics, soil fertility, soil bacteriology, soil humus, and soil management. For the Doctor's degree, major and minor work is offered in soil fertility, soil bacteriology, and soil humus.

In order to register for graduate work in agronomy, a student must have obtained his baccalaureate degree from an institution of recognized standing.

The Department of Agronomy has eight commodious and well equipped soil laboratories for scientific work; suitable greenhouses and field plots for study and experimentation in soils and crops; valuable data secured from extensive soil and crop experiments; photographs, charts, and maps which serve the needs of advanced students.

The Iowa Section of the American Society of Agronomy, composed of the graduate students in Agronomy and the department faculty, meets once a month during the college year for the discussion of reports and the encouragement of research work.

The following studies are open to graduates:

Special Problems in Production and Breeding of Farm Crops; Methods of Crop Investigation; Experimentation Methods and Work; Judging; Small Grain and Forage Crops; Research in Plant Breeding; Research in Crop Production; Research in Soil Physics; Research in Soil Management; Soil Bacteriology; Research in Soil Bacteriology; Research in Soil Humus. See page 106, General Catalog.

### Animal Husbandry

Professors Pew, Kildee, Turpin; Associate Professors Vaughn, Lloyd-Jones, Shearer, Ikeler, Ferrin; Assistant Chief Evvard; Assistant Professor Gillette

The department offers major and minor work for the Master's degree along the lines of animal nutrition and feeding, animal breeding, live stock management, dairy husbandry, and poultry husbandry, and major and minor work for the Doctor's degree along the lines of nutrition, genetics, and dairy husbandry.

The student who enters upon graduate work in animal husbandry must have, in addition to a Bachelor's degree, a general knowledge of zoology, inorganic and organic chemistry, and he must be qualified by training to

undertake the special line of work which he elects. The major work must be selected from one of the above lines and a suitable thesis written. Minor subjects may be elected in this or another department.

The equipment of the Animal Husbandry Department consists of an excellent collection of horses representative of the market classes and breeds, among which are the Shires, Percherons, Clydesdales, Belgians, Standardbreds, and American Saddle horses; one hundred seventy-five head of cattle, representing all of the leading beef and dairy breeds, among which are ninety representatives of the Holsteins, Jerseys, Guernseys, Ayrshires, with good sires of the different breeds; two hundred head of seven different breeds of sheep; six breeds of the best American and British varieties of swine; herd books, photographs, charts, and lantern slides; a well equipped twenty-acre poultry farm; and a two-hundred-acre dairy farm. In addition there are maintained for purpose of research in nutrition and breeding a herd of some 300 swine, a hundred sheep and cattle, stocks of small laboratory animals, as well as appropriately plotted fields, and laboratory and barn equipment, for their best use.

The Graduate Club in Animal Husbandry holds monthly meetings for the discussion of current literature and the encouragement of research work.

The following lines of study are open to graduates:

Live Stock Production, Feeding, Management, and Judging; Milk and Wool Production; Herd Book Study; Animal Nutrition; Market and Breeding Types of Poultry; Genetics; Seminars; Research. See page 115 of General Catalog.

### Bacteriology and Hygiene

Professors Buchanan, Brown; Associate Professors Murray, Hammer; Assistant Professor Levine

Major and minor work leading to the degrees of Master of Science and Doctor of Philosophy are offered.

The student who elects his major in any field of bacteriology should present undergraduate credits in organic chemistry, one semester of physics, the equivalent of Course 1 in Bacteriology, and an elementary course in the line in which he expects to major. Ordinarily a student must do two-thirds of his work in one of the lines of bacteriology above mentioned.

The department, beginning with September, 1916, will be housed in the new Science Building in which provision for graduate as well as undergraduate instruction has been made. Studies for graduate students will be offered in the laboratories in this and other buildings in those phases of bacteriology which have important relations to agriculture, home economics, the industries, sanitary engineering, and veterinary medicine.

The research problems that are now receiving attention are identification and classification of organisms of importance in sewage disposal, the recognition of sewage pollution, the disposal of creamery waste, the organisms responsible for silage preservation, the influence of various bread ingredients upon the yeasts used in bread making, the bacteria and yeast

responsible for the spoiling of foods, crown gall of the apple, and diseases of the honey bee.

The Department of Bacteriology maintains a seminar which meets weekly and has for its object the discussion of current literature in its field of bacteriology.

The following studies are open to graduates:

Agricultural Bacteriology; Advanced Agricultural Bacteriology; Seminars; Veterinary Pathogenic Bacteriology; Immunity and Serum Therapy; Zymotechnique and Household Bacteriology; Dairy Bacteriology; Industrial Sanitary Bacteriology; Research in any of the preceding lines. See page 125, General Catalog.

### **Botany**

Professor Pammel; Associate Professors Martin, Melhus; Assistant Professor Bakke

The department offers major and minor work for the degrees, Master of Science and Doctor of Philosophy in those fields of Botany which find their application in agriculture, horticulture, forestry, and the industries. For this purpose graduate and research work in vegetable pathology, morphology, physiology, systematic and economic botany are offered.

Some of the research work receiving special attention at this time is alfalfa and clover pollination studies, the distribution of forest trees, transpiration of plants, honey plants of Iowa, rust investigations, fusarium disease of corn, crown gall, cabbage yellows, clover and alfalfa diseases, and corn root moulds.

The Department of Botany maintains a seminar which is composed of the members of the department and the advanced students. The object of this seminar is the discussion of recent botanical literature and the presentation of papers by the members.

The following studies are open to graduates:

Plant Embryogeny; Botany of Weeds; Evolution of Plants; General and Experimental Morphology; Methods of Histology; Cytology and Methods of Histology; Fungi; Physiology, Ecology, Agrostology; Systematic Botany; Dendrology; Mycology; Vegetable Pathology; Range and Poisonous Plants; Botanical Seminars; Cytology; Advanced course in Thallophytes; Applied Botany; Microscopical Examination of Foods; Seed Testing; Poisonous Plants; Pathological Physiology; Research. See page 131 in General Catalog.

### **Ceramics**

Professor Beyer; Associate Professor Staley; Assistant Professor Galpin

The department offers major and minor work for the degree of Master of Science along the lines of ceramic technology of crude and fine clay products, the technology of glass and enamel making, the geology of clays and ceramic materials, microscopic study of clays, and ceramic materials and cement making.

The Department of Ceramics maintains a clay working laboratory equipped with up-to-date machinery; kiln rooms with both up- and down-draft experimental kiln using solid fuel, and a pottery kiln in which oil is burned; a drying and physical testing room with all the necessary utensils for making up and testing clays and other ceramic materials; and a gas

and fuel testing room equipped with an improved Elliott apparatus for gas analysis, a Parr calorimeter for solid fuels, a Junker calorimeter for gas and oils, Le Chatelier electric, a Wanner optical, and a Brown metallic pyrometer.

The following studies are open to graduates:

Ceramic Lectures; Ceramic Design; Special Problems; and Research in the above lines of work. See page 140, General Catalog.

For the professional degree of Ceramic Engineer see page 16.

### Chemical Engineering

Professors Beyer, Coover; Associate Professor Mann

Students majoring for advanced degrees in other departments of the Engineering, Industrial Science, and Agricultural Divisions may minor in chemical engineering. At the present time the department is not offering all of the requirements for the degree of Master of Science.

The Chemical and Engineering Departments are provided with facilities for investigation of manufacturing problems and for conducting industrial research according to a practical system of coöperation between science and industry. These facilities are open to graduate students in chemical engineering.

The following studies are open to graduates:

Industrial Chemistry; The Chemistry of the Manufacture of Foods; Chemical Machinery; Applied Electrochemistry; Municipal Chemistry; and Research in Manufacturing Problems. See page 145 in General Catalog.

For the professional degree of Chemical Engineer see page 16.

### Chemistry

College Department Staff: Professor Coover; Associate Professors Fowler, Mann, Test, Wilkinson, Renshaw; Assistant Professor Burchanan. Agricultural Experiment Station Staff:

Chief Dox. Engineering Experiment Station Staff: Chief Coye.

The Department of Chemistry offers major and minor work for the Master's and Doctor's degrees in those fields of chemistry applicable to agriculture, engineering, home economics, veterinary medicine, and the industries.

In the Agricultural Experiment Station thesis work is offered in agricultural and biological chemistry. In the Engineering Experiment Station thesis work is offered in industrial chemistry and the chemistry of road materials.

The department now occupies its new building wherein adequate provision has been made for research laboratories and for a department library which contains fairly complete files of all the more important chemical periodicals as well as a large and well selected collection of books on the different phases of the subject.

Besides the departmental seminar which meets every week for the discussion of recent developments and publications in the above fields, there

is a local section of the American Chemical Society which meets about once a month, and a Chapter of the Phi Lambda Upsilon fraternity which holds monthly meetings to discuss current literature and investigations.

The following studies are open to graduates:

Advanced Inorganic Chemistry; Research in Applied Inorganic Chemistry; Advanced Qualitative and Quantitative Analysis; Research in Analytical Chemistry; Applied Physical Chemistry; Electro-chemistry; Research in Applied Physical Chemistry; Analysis of Carbon Compounds; Manufacture of Fine Organic Chemicals; Applied Organic Chemistry; Research in Applied Organic Chemistry; Food Analysis; Research in Food Analysis; Dairy Chemistry; Sanitary Chemistry; Agricultural Chemistry; Research in Agricultural Chemistry; Physiological Chemistry; Research in Metabolism; Industrial Chemistry; Chemical Machinery; and Municipal Chemistry; Textiles; Animal and Plant Chemistry; Research in Physiological Chemistry; Research in Industrial Chemistry. See page 148, General Catalog.

### Civil Engineering

Professors Kirkham, King, Agg; Associate Professors Evinger, Crum

The department offers major work for the degree of Master of Science in Civil Engineering along the lines of masonry structures and experimental engineering, railway engineering, structural engineering, hydraulic and sanitary engineering, masonry design, highway engineering; and minor and supporting work in the other departments of the Engineering, Agricultural, and Industrial Science Divisions. Students may therefore major in civil engineering and minor in any department of the Agricultural and Industrial Science Divisions which offers a correlated line of work, and vice versa.

The Department of Civil Engineering occupies nine rooms in the Engineering Hall, eight rooms in the Structural and Hydraulics Laboratory, four rooms in the Engineering Annex, and the entire Transportation Building. Included within the eleven engineering buildings there are the following laboratories and drafting rooms: the cement laboratory; the structural materials laboratories; the hydraulics laboratory; laboratory for testing non-bituminous road materials; the bituminous materials laboratory; and six large drafting rooms. The equipment for advanced work in these laboratories is of the best on the market and is sufficient to accommodate many graduate engineering students.

The following studies are open to graduates:

Water Purification; Sewage Treatment and Municipal Wastes Disposal; Elements of City Planning; Seminars; Water Supply; Railway Design; Railway Operation; Advanced Structural Engineering; Road Materials; Experimental Work in Civil Engineering; Masonry Design; Highway Engineering; Roads and Pavement Design; and Railway Engineering. See page 160 in General Catalog.

For the professional degree of Civil Engineer see page 16.

### Dairying

Professor Mortensen; Associate Professor Hammer; Assistant Professor Rudnick

The Department of Dairying offers major and minor work for the Master's degree along the lines of management of dairy plants, dairy bacteriology, and creamery products.

In correlation with the fundamental sciences the department also offers

major and minor work for the Doctor's degree in management of dairy plants and dairy bacteriology.

The department occupies the entire four-story dairy building which contains the different laboratories equipped for investigation along the lines in which graduate work is offered. The dairy faculty and graduate students hold regular conferences for the discussion of recent scientific literature and practical developments in the field of dairying.

The following studies are open to graduates:

Factory Management; Fancy Ice Creams and Ices; Judging Dairy Products; Milk Testing and Inspection; Seminars; Market Milk; Dairy Bacteriology; Research in Dairy Bacteriology, Ice Cream Making, Butter Making, and Creamery Management; Research. See page 179 in General Catalog.

### Economic Science

#### APPLIED ECONOMICS AND SOCIAL SCIENCE

Professor Brindley; Associate Professors Von Tungeln, Rankin; Instructor Baker

The Department of Economic Science offers major and minor work for the Master's degree in those fields of Economic Science applicable to agriculture, engineering, home economics, veterinary medicine, and the industries.

The different libraries of the college contain many of the best reference works, journals, magazines, and government publications bearing on agricultural economics, engineering economics, and rural sociology. Research work in rural sociology is carried on during the summer.

The department maintains an applied social science club in coöperation with the History Department. The purpose of this club is the discussion of current economic and social questions within the field of the department and the encouragement of research work.

Studies along the following lines are open to graduates:

Problems in Advanced Agricultural Economics; Marketing of Agricultural Products; Rural Sociology; Economics of Business Engineering; Research. See page 183 in General Catalog.

### Electrical Engineering

Professor Fish; Associate Professors Bartholomew, Wright; Assistant Professors Robbins, Paine

The Department of Electrical Engineering offers opportunity for major work leading to the degree of Master of Science in Electrical Engineering. The subjects offered are advanced theory of alternating currents, electric power transmission, electric railways, and advanced work on the operating characteristics of electrical apparatus.

Opportunity for minor work is also given to those majoring in other departments of Engineering and in the departments of the Industrial Science and Agricultural Divisions.

The department has its offices in the Engineering Annex. The Engineering Annex also contains the electrical laboratory with twenty-

eight generators and motors of various manufacture, several transformers, over one hundred accurate instruments, mounted lamp banks, rheostats, choke coils, and other apparatus. A substation motor-generator set, which has a 100 horse-power, three-phase, 60 cycle, 1100-volt, 1200-r. p. m. induction motor takes power from the College central power plant. To one end of the motor is coupled a 60-kilowatt, 125-volt, compound wound, direct-current generator and to the other end is coupled a 50-kilowatt, three-phase, 60-cycle 220 and 110-volt alternator. The various experimental machines consist of shunt, series, interpole, and compound wound generators and motors, alternating current synchronous and induction motors, revolving field alternators, and double current generators. Individual switchboards are mounted with instruments and control apparatus for student use.

The following studies are open to graduates:

Principles of Electrical Engineering; Direct and Alternating Current Machinery; Seminars; and advanced work in the studies above mentioned. See page 187 in General Catalog.

For the requirements for the professional degree of Electrical Engineer, see page 16.

### Farm Management

Professor Munger; Assistant Chief Lloyd

Major and minor work leading to the Master's degree is offered by the department in farm management, including studies of farm tenancy, cost of production, and farm practice.

Students who major in this department must have a baccalaureate degree in farm management from an institution of recognized standing.

The business of farming requires special training in farm management to prepare investigators, teachers, and farm management demonstrators. The demand for men who are experts in these fields of work is large and it is becoming more and more necessary for students who intend to take up farm management work to have graduate training.

The following studies are open to graduates:

Research in Farm Tenancy and Cost of Production; Thesis; and Seminars. See page 201 in General Catalog.

### Forestry

Professors Beach, MacDonald; Associate Professor Morbeck

The department offers a five year course leading to the degree of Master of Science in Forestry, and major and minor work for the Master's degree along the lines of forest protection, forest management, lumbering, and forest products.

The student entering upon the work for an advanced degree must have completed a four year course in forestry.

Forestry is housed in Agricultural Hall where laboratory and class room space is afforded. The museum contains the collection of American woods which was exhibited by Iowa at the Centennial exposition; a large collection of South American and Philippine Island woods which were on

display at the Louisiana Purchase exposition; a large number of trunk specimens of trees; and about 800 lantern slides. The College has a 100-acre woods tract which serves as a demonstration area and 150 different species of trees are found on the campus.

The following studies are open to graduates:

Advanced Forest Management; Advanced Forest Regeneration; Forestry Research; Wood Structure; Grading Lumber; Forest Protection; Forest Valuation; Timber Preservation; Municipal Forestry; Economic Woods; Silviculture; Lumbering; Forest Products. See page 204 in General Catalog.

### Geology

Professor Beyer; Assistant Professor Galpin

The department offers major and minor work for the Master's degree along those lines in which geology has an intimate relationship to mining engineering, soil formation, etc. The department also offers major work for the degree of Doctor of Philosophy in the fields of economic geology and petrology.

The museum contains several selected series of fossils, minerals, rocks and ores, from the different sections of the United States. Among these are the series of rocks collected by the United States Geological Survey; the series of rocks and minerals collected by the Smithsonian Institution; the Calvin series of paleozoic fossils; the Coastal Plain fossils from New Jersey, Alabama, Maryland and Virginia; The English mineral collection; the Permo-Carboniferous series from Kansas and Russia, and from the coal plants of Iowa, Illinois, and Pennsylvania; a large series of lead and zinc ores from the different fields in the United States; and the Dr. H. Foster Bain series of rocks and minerals.

The laboratory is equipped for scientific study in the lines in which major work is offered.

The following studies are open to graduates:

Petrology; Optical and Physical Mineralogy; Petrography; Topographic and Geologic Mapping and Economic work; Economic Geology; Stratigraphic Geology; and Cartography. See page 217 in General Catalog.

### Home Economics

Professor MacKay; Associate Professors Russell, Gettemy, Monsch; Assistant Professor Schermerhorn

The department offers minor work for the Master's degree along the lines of dietetics, theory of practice, sewing, and applied art. The department offers no major work for the Master's degree, but a student with a major in any department of the Industrial Science Division may minor in Home Economics.

The department occupies the entire three story Home Economics Building and it has had, during the past year, nearly six hundred students.

The studies which may be chosen as minors in graduate work are:

Nutrition and Dietetics; Theory and Practice of Teaching Home Economics; Advanced Dressmaking; Millinery; Costume and Textile Design; Home Architecture and Sanitation; and History of Art. See page 225 in General Catalog.

### Horticulture

Professor Beach; Chiefs Erwin, Greene; Associate Professor Culley

The department offers major and minor work for the Master's degree along the lines of general horticulture, pomology, truck crops, landscape gardening, and floriculture; and major and minor work for the Doctor's degree along the lines of plant breeding and pomology.

The student who elects horticulture as his major is expected to have taken as undergraduate work the equivalent of a course leading to the degree of Bachelor of Science in Horticulture in a standard institution.

To aid in practical and scientific investigation the department has on the campus and college farm about sixty acres devoted to orchards, nurseries, vineyards, and gardens. The Horticultural Experiment Station has the management of a twenty-three acre orchard at Council Bluffs, which is especially valuable for departmental work. The new plant laboratory building and greenhouses which are fully equipped and which supply 30,000 feet under glass, give exceptional advantages for research study. In this new building a special research laboratory has been arranged for advanced investigational work.

The following studies are open to graduates:

Plant Breeding; Research in Plant Breeding; Fruit Farm Management; Advanced Floriculture; Research in Floriculture; Market Gardening; Research in Pomology, Truck Crops; Truck Farm Management, Special Problems, Research, Landscape Gardening, Special Problems, Landscape Design, Maintenance and Construction, Shade and Park Tree Management. See page 234 in General Catalog.

### Mathematics

Professors Stanton, Roberts; Associate Professors Colpitts, Pattengill, Chaney, Snedecor; Dr. Tappan

The Department of Mathematics offers major and minor work for the Master's degree in the special fields of this college.

The subjects offered are so correlated to the different lines of work as to merit consideration of those students who expect to become teachers and investigators in applied mathematics.

By special arrangements students majoring in mathematics may minor in engineering, physics, chemistry, or any of the biological sciences, if the work in such sciences is mathematical in character.

To stimulate an interest in higher mathematics and current mathematical literature a colloquium composed of members of the department and advanced students holds regular meetings.

The following studies are open to graduates:

Theory of Equations; Determinants and Advanced Analytic Geometry; Advanced Spherical Trigonometry; History of Mathematics; Advanced Differential and Integral Calculus; The Theory of Functions; Differential Equations; Projective Geometry; Higher Algebra; Infinite Series; Mathematical Theory of Statistics; Mathematics as Applied to Economic Problems; Theoretical Mechanics; Theory and Applications of Vector Analysis; Advanced Dynamics; Differential Equations of Mathematical Physics; and the Mathematical Theory of Electricity and Magnetism. See page 256 in General Catalog.

### Mechanical Engineering

Professor Meeker; Associate Professors Cleghorn, Major, Norman

The department offers major work for the degree of Master of Science in Mechanical Engineering along the lines of gas engineering, steam engineering, heating and ventilation, machine designing, railway mechanical engineering, automobile engineering; and minor and supporting work in the other departments of the Engineering, Agricultural, and Industrial Science Divisions.

The general offices of the department are in the Engineering Hall. The lecture and drafting and blue-print rooms are in the Engineering Hall and Engineering Annex. The department occupies the Steam and Gas Laboratory Building; the Locomotive Building; Machine Shop Building; Forge Shop Building; and the Foundry and Pattern Shop Building. The Steam and Gas Laboratory has a 150 H. P. cross compound Nordberg engine; a 535 cubic foot air compressor; a Kerr Steam Turbine connected to a 35 kilowatt, 220 volt alternating current generator; three other steam engines of different types; condensers, various types of air brakes; several types of steam and power pumps; a 50 H. P. suction gas producer and engine; four gas engines; one oil engine; a 1000 lb. refrigerating machine; all necessary small apparatus; a 50,000 lb. Olsen Testing machine; a 2,500 foot pound Olsen Torsion machine; and an American Type eight wheel locomotive given the College by the C. & N. W. Ry. Co. for testing purposes. The Machine Shop, Forge Shop, Foundry and Pattern Shop are each well equipped for scientific work.

The following studies are open to graduates:

Mechanics of Engineering; Hydraulics; Heating Design; Machine Work; Seminars; Machine Design; Steam Engines and Boilers; Power Plant Engineering; Steam and Gas Laboratory; Crane Design; Gas Engine Construction and Operation; Gas Engine Design; Power Engineering; and Railway Mechanical Engineering. See page 262 in General Catalog.

For the requirements for the professional degree of Mechanical Engineering, see page 16.

### Mining Engineering

Professor Beyer; Associate Professor Hodson

All of the subjects offered are required of undergraduates who specialize in Mining Engineering and Metallurgy, but may be elected for minor work by graduates who are majoring along other lines. The department does not, at the present time, offer major work for an advanced degree.

The department occupies six rooms in Engineering Hall and six rooms in the Engineering Annex and Ceramics Building. The museum for geology and mining engineering is well equipped for the technical work of mining engineers. A complete Sullivan diamond drill prospecting outfit, a Water Leyner air drill, a complete set of miner's drills and tools, prospector's pans, picks, anemometers, barometers and clinometers, and mine, geological, and topographical maps of the most important mining districts add to the equipment. Wet and Dry metallurgical laboratories with the latest and best apparatus are maintained for all students.

The following studies are open to graduates:

Assaying; Mining Engineering; Metallurgy; and Seminars. See page 277 in General Catalog.

For the requirements for the professional degree of Engineer of Mines see page 16.

### Physics

Professor Spinney; Associate Professors Stiles, Thompson; Assistant Professors Kunerth, Plagge

Major and minor work leading to the degree of Master of Science is offered by the department in those fields of physics which are fundamental to the development of any line of work in the college.

To encourage graduate and research work the Department of Physics maintains well equipped laboratories and a Colloquium composed of teachers and advanced students. The Colloquium meets once a week to discuss research work and recent articles and developments in the field of physics.

The following studies are open to graduates:

Mechanics; Heat and Light; Electricity and Magnetism; Advanced courses in Heat and Light; Illumination; Electron Theory and Radioactivity; History of Physics; Wave Motion and Sound; Theory of Electricity and Magnetism; Industrial Physics; Theory of Light; Theory of Heat; Research. See page 295 in General Catalog.

### Structure Design

Professor Kimball

The department offers major and minor work for the degree of Master of Science along the lines of design of industrial structures, rural buildings, and the design and construction of tall office buildings.

The Department of Structure Design offers work to students who wish to study interesting problems in building construction. The work is so arranged that many different classes of buildings are studied and worked out in detail. With the facilities offered in the way of valuable library material as well as the equipment of the shops it is possible to carry out many problems in design both from the practical and theoretical standpoints. The ultimate aim of the work is to give students the opportunity to make special application of the principles learned during the undergraduate course.

The following studies are open to graduates:

Special Interior Design; Advanced Design; Seminars; Elements of Structural Design as Applied to Agricultural Structure; Advanced Freehand Drawing; History of Structure Design; Industrial Structures; Sanitation of Buildings; and Estimating. See page 302 in General Catalog.

### Veterinary Anatomy

Professor Murphrey

Major and minor work for the degree of Master of Science are offered by the department in histology and in gross anatomy. Minor work in anatomy is suggested for students majoring in animal nutrition, biological chemistry, pathology, physiology, and zoology.

The department is equipped to give instruction in the most scientific phases of anatomy to students of Veterinary Medicine or Animal Husbandry. The laboratories are all well equipped. In Histology and Osteology each student is assigned an individual desk provided with a microscope, 100 permanent mounts of tissue, laboratory notes, and one-half skeleton of disarticulated bones of the horse. A large and technically prepared list of specimens is used in the class and laboratory demonstrations.

The following studies are open to graduates.

Osteology and Arthrology; Microscopy and Microscopic Anatomy; Myology and Splanchnology of the Horse; Microscopic Anatomy of the Organs of the Domestic Animals; Myology, Angiology, Neurology, Topography; Anatomy of Domestic Animals; Comparative Anatomy; Research in Anatomy. See page 310 in General Catalog.

### **Veterinary Pathology and Bacteriology**

Professor Dimock; Associate Professor Murray

The department offers major and minor work leading to the Master's degree along the lines of systemic pathology, the pathology of specific infectious diseases, the pathology of sporadic diseases, tumors, chemical pathology, veterinary bacteriology, immunity and serum therapy.

Students who major in veterinary bacteriology including immunity and serum therapy will classify with the Department of Bacteriology in the Industrial Science Division, but will do their work in the Department of Veterinary Pathology and Bacteriology. Students who major in pathology will classify in the Department of Veterinary Pathology and Bacteriology.

The Department of Pathology and Bacteriology occupies the north-east building of the veterinary group. The building was planned and arranged for the work given in this department. Two offices open directly into a private laboratory which is used by the men in charge to investigate problems pertaining to their lines of work. A large general laboratory faces the north and has windows on the sides, supplying the best possible light for microscopic work. Each of the thirty individual desks in this laboratory has a plate glass top, making possible the perfect sanitary conditions necessary in handling infectious material. The desks are supplied with gas lamps, microscopes, and accessories necessary for carrying on work in both pathology and bacteriology. In connection with this laboratory there are two well equipped preparation rooms, one devoted to work in pathology and the other to work in bacteriology. The department also has the use of a large class room which is provided with lantern slide and microscopic projection equipment.

The following studies are open to graduates.

General Pathology; Special Pathology; Advanced Pathology; Immunity and Serum Therapy; Research in Pathology; and Research in Bacteriology. See page 312 in General Catalog.

### **Veterinary Physiology and Pharmacology**

Associate Professor Bergman

The department offers major work for the Master's degree along lines of investigation of physiological subjects relative to veterinary science;

and minor and supporting work in physiology for graduate students in the Industrial Science Division or for agricultural students who are doing their major work along such lines as general nutrition, production problems, feeding, breeding, etc.

Students who major in physiology for an advanced degree must have had such previous training in physiology, and related subjects, such as anatomy, histology, chemistry, etc., as will permit of advanced study.

The southeast building of the Veterinary group is devoted to the work in Physiology, Pharmacy, Materia Medica, and Therapeutics. The laboratories are well equipped for general and research work in physiology.

The following studies are open to graduates.

Comparative Physiology; Advanced Comparative Physiology; and Research in Physiology; Seminar. See page 314 in General Catalog.

### **Zoology**

Professor Summers; Associate Professors Guthrie, Bartholomew; Assistant Professors Harrison, Scullen, Ewing

The department offers major and minor work for the Master's degree along the lines of entomology, comparative physiology, invertebrate and vertebrate comparative anatomy; and major work for the Doctor's degree along the lines of entomology and comparative physiology. Majors in any of these lines are research work.

The Department of Zoology embraces zoology and entomology. Beginning in the fall of 1916 zoology will be located on the second and third floors of the new Science Hall, while the entomology is housed in the Hall of Chemistry. The department maintains well equipped laboratories and libraries for graduate and research work, and a Zoology Club which meets weekly for the review of recent books and articles, and the presentation of papers on original work.

The following studies are open to graduates.

Evolution of Animals; Vertebrate Comparative Anatomy; Morphology; Advanced Invertebrate Comparative Anatomy; Advanced Entomology; Neurology; Economic Entomology; Orchard and Nursery Inspection; Literature of Entomology; Research in Entomology, Apiculture, Comparative Physiology, and Embryology. See page 320 in General Catalog.

### **DEPARTMENTS OFFERING MINOR WORK ONLY**

The work in the following departments is undergraduate in character and is subordinate and auxiliary to the work of the departments which offer major lines.

#### **Agricultural Education**

Professor Wilson; Associate Professor Sealock; Assistant Professors Schermerhorn, Gibson

The department offers minor work in certain fundamental courses which should be taken by one who expects to teach technical subjects.

The demand for the professional training of teachers has gradually extended upward through the grades and high school, until now many col-

leges give it consideration in the selection of members of the instructional staff. Because of the evident tendency to require professional training, any graduate student who expects to teach is urged to elect work in this department as a minor if he has not already completed at least fifteen hours of such work. Students in this college who remain for a fifth year may well consider making this work one of the lines to be followed.

The studies open, as minors only, to graduates are:

Educational History; Vocational Education; School Administration; Methods and Practice Teaching; and Research in Agricultural Education. See page 88 in General Catalog.

### History

Professor Cessna; Associate Professor Schmidt

Students majoring for advanced degrees in agriculture or industrial science or applied economics and social science may minor in history. The department offers a number of specialized studies in economic history, the chief purpose of which is to furnish an historical foundation for the study of the present day economic and social problems in industrial fields.

The college and history seminar libraries contain the best standard reference works, journals, magazines, and government publications bearing on these subjects.

The following studies, as minors only, are open to graduates:

Economic History of American Agriculture; Industrial History of England; History of Immigration to the United States; Iowa History; History of Transportation in the United States; History of the United States as a World Power; Economic History of the United States, 1860-1880; Tariff History of the United States; and Research in Economic History. See page 222 in General Catalog.

### Psychology

Professor Cessna; Assistant Professor Vance

Students majoring for advanced degrees in agriculture or industrial science or applied economics and social science may minor in psychology. It is evident that all subjects involving the human element must be based on the knowledge of the laws of mental action. The study of psychology is regarded as necessary to the proper understanding of such problems as industrial development and efficiency, rural social uplift, etc.

The following studies, as minors only, are open to graduates:

Ethics; Social Psychology; Psychology of Childhood and Adolescence; Educational Psychology; Psychology of Business; The Animal Mind; and Physical and Mental Tests. See page 298 in General Catalog.

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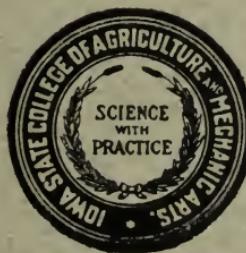
OF

## AGRICULTURE AND MECHANIC ARTS

### THE GRADUATE DIVISION

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1917-1918

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Vol. 16

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## The College

The Iowa State College of Agriculture and Mechanic Arts conducts work along five major lines:

AGRICULTURE  
ENGINEERING  
HOME ECONOMICS  
INDUSTRIAL SCIENCE  
VETERINARY MEDICINE

The Graduate Division conducts advanced research and instruction in all these five lines.

Four, five, and six year collegiate courses are offered in different divisions of the College. Non-collegiate courses are offered in agriculture, engineering, and home economics. Summer Sessions include graduate, collegiate, and non-collegiate work. Short courses are offered in the winter.

Extension courses are conducted at various point throughout the state.

Research work is also conducted in the Agricultural and Engineering Experiment Stations and in the Veterinary Research Laboratory.

Special announcements of the different branches of the work are supplied, free of charge, on application. The general college catalogue will be sent on request.

Address HERMAN KNAPP, Registrar,  
Ames, Iowa.

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## Iowa State Board of Education

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\*P. E. McClenahan, Inspector.....Des Moines  
John E. Foster, Inspector.....Des Moines

\* Absent on leave.

# The College Calendar

1917-1918

*As Applicable to the Graduate Division*

## FIRST SEMESTER

September 6-7—Entrance examinations.  
September 10-11—Registration of graduate students.  
September 12, 7:40 a. m.—Lectures begin.  
September 15, 8:00 p. m.—Y. W. C. A. & Y. M. C. A. reception.  
November 29—Thanksgiving vacation.  
December 19, 12:00 m.—Christmas vacation begins.  
January 2, 12:00 m.—Vacation closes.  
January 25, 12:00 m.—First semester closes.

## SECOND SEMESTER

January 31-February 1—Entrance examinations.  
February 4-5—Registration of graduate students.  
February 6, 7:40 a. m.—Lectures begin.  
February 9, 8:00 p. m.—Y. W. C. A. & Y. M. C. A. reception.  
March 28, 12:00 m.—Easter vacation begins.  
April 1, 5:00 p. m.—Easter vacation closes.  
May 1, 12:00 m.—Latest day for receipt by Dean of the Graduate Division of certified copies of Doctors' Theses.  
May 25, 12:00 m.—Latest day for receipt by Dean of the Graduate Division of certified copies of Masters' Theses.  
June 2, Sunday, 10:30 a. m.—Baccalaureate sermon.  
June 4, Tuesday, 9:30 a. m.—Alumni business meeting.  
June 5, Wednesday, 1:00 p. m.—Alumni, faculty, senior banquet.  
June 6, Thursday, 10:30 a. m.—Commencement.  
June 6, Thursday, 2:30 p. m.—President's reception.

## SUMMER SESSION

June 10, Monday, 7:00 a. m.—Summer session begins.  
August 29, Thursday, 12:00 m.—Summer school closes.

1918-1919

## FIRST SEMESTER

September 5-6—Entrance examination.  
September 9-10—Lectures begin.

# Faculty of the Graduate Division

## President and Deans

Raymond Allen Pearson. 1912.....President  
B. S. in Agr., Cornell University, 1894; M. S. in Agr., 1899; LL.D.,  
Alfred University, 1909; D. of Agr., University of Nebraska, 1917.

Edgar Williams Stanton. \*\*1877, 1873.....Vice-President, Dean of the  
Junior College, Professor of Mathematics  
B. Sc., Iowa State College, 1872; M. Sc., 1887; LL.D., Coe College,  
1904.

Charles Franklin Curtiss. 1897, 1891.....Dean of the Division of  
Agriculture, Director of Experiment Station  
B. S. A., Iowa State College, 1887; M. S. A., 1892; D. S. in Agri-  
culture, Michigan Agricultural College, 1907.

Anson Marston. 1892....Dean of the Division of Engineering, Professor  
C. E., Cornell University, 1899. of Civil Engineering

Charles Henry Stange. 1909, 1907....Dean of the Division of Veterinary  
Medicine, Professor of Veterinary Theory and Practice  
D. V. M., Iowa State College, 1907.

Robert Earle Buchanan. 1909-1904....Dean of the Division of Industrial  
Science, Professor of Bacteriology  
B. S., Iowa State College, 1904; M. S., 1906; Ph. D., Chicago Uni-  
versity, 1908.

Catharine J. MacKay. 1911, 1910.....Dean of the Division of Home  
Economics, Professor of Home Economics  
Diploma, Drexel Institute, 1907; Boston Cooking School, 1907; Teach-  
ers' College, Columbia University, 1910, 1914.

## Professors

Spencer Ambrose Beach. 1905.....Vice-Dean of the Division of  
Agriculture, Professor of Horticulture  
B. S. A., Iowa State College, 1887; M. S., 1892.

Harold Edward Bemis. 1913, 1908.....Vice-Dean of the Division of  
Veterinary Medicine, Professor of Veterinary Surgery  
D. V. M., Iowa State College, 1908.

Henry Dale Bergman. 1916, 1910.....Professor of Physiology and  
D. V. M., Iowa State College, 1910. Pharmacology

Samuel Walker Beyer. 1898, 1891....Vice-Dean of the Division of Engi-  
neering, Professor of Geology and Mining Engineering  
B. S., Iowa State College, 1889; Ph. D., Johns Hopkins Univ., 1895.

\* The Graduate Faculty is composed of the president, deans, heads of departments  
in which graduate instruction is authorized, and other members of the faculties who  
are in charge of graduate instruction.

John Edwin Brindley. 1913, 1907.....Professor of Economics  
B. L., University of Wisconsin, 1902; A. M., 1906; Ph. D., University  
of Iowa, 1911.

Percy Edgar Brown. 1914, 1910.....Professor of Soil Bacteriology  
B. Sc., Rutgers College, 1906; A. M., 1909; Ph. D., 1912.

Orange Howard Cessna. 1900.....Professor of History and Psychology  
B. S., Iowa State College, 1872; B. D., Garrett Biblical Institute, 1885;  
D. D., 1900; A. M., Cornell College, 1901.

Winfred Forest Coover. 1913, 1914.....Professor of Chemistry  
A. B., Otterbein University, 1900; A. M., Ohio State University, 1903.

Martin Francis Paul Costelloe. 1916, 1911.....Professor of Agricultural  
Engineering  
B. S. in C. E., University of Nebraska, 1906; A. E., 1916.

William Wallace Dimock. 1911, 1909.....Professor of Veterinary  
Pathology and Bacteriology  
B. Agr., Connecticut Agricultural College, 1901; D. V. M., Cornell  
University, 1905; D. V. M., University of Habana, 1907.

Fred Alan Fish. 1907, 1905.....Professor of Electrical Engineering  
M. E. in E. E., Ohio State University, 1898.

Bernard Wernick Hammer. 1916, 1911...Professor of Dairy Bacteriology  
B. S. A., University of Wisconsin, 1908.

Harald De Mott Hughes. 1910.....Professor of Farm Crops  
B. S., University of Illinois, 1907; M. S. A., Univ. of Missouri, 1908.

Gilmour Beyers MacDonald. 1913, 1910.....Professor of Forestry  
B. S. F., University of Nebraska, 1907; M. F., 1914.

Warren H. Meeker. 1907, 1891....Professor of Mechanical Engineering  
M. E., Cornell University, 1891.

Martin Mortensen. 1909.....Professor of Dairying  
B. S. A., Iowa State College, 1909.

Harlan Bruce Munger. 1914.....Professor of Farm Management  
B. S., Cornell University, 1912.

Howard Sylvester Murphey. 1913, 1909.....Professor of Veterinary  
D. V. M., Ohio State University, 1908. Anatomy and Histology

Louis Hermann Pammel. 1889.....Professor of Botany  
B. Agr., University of Wisconsin, 1885; M. S., 1889; Ph. D., Wash-  
ington University, St. Louis, 1898.

William Harper Pew. 1912, 1909.....Professor of Animal Husbandry  
B. S. A., Iowa State College, 1907.

Maria M. Roberts. 1913, 1891..Vice-Dean of the Junior College, Professor  
B. L., Iowa State College, 1890. of Mathematics

Louis Bevier Spinney. 1897, 1891.....Professor of Physics  
B. M. E., Iowa State College, 1892; B. S. (E. E.), 1893.

Homer Francis Staley. 1916, 1914.....Professor of Ceramic Engineering  
B. A., Ohio State University, 1904.

William Henry Stevenson. 1903, 1902.....Professor of Agronomy, Vice-  
Director of Experiment Station  
A. B., Illinois College, 1893; B. S. A., Iowa State College, 1905.

George Melvin Turpin. 1913.....Professor of Poultry Husbandry  
B. S., in Agr., Utah Agricultural College, 1909.

Guy Mitchell Wilson. 1913.....Professor of Agricultural Education  
A. B., Indiana University, 1900; M. A., 1908.

### Associate Professors

George Arthur Chaney. 1914, 1913...Associate Professor of Mathematics  
M. S., Highland Park College, 1906; M. A., Univ. of Wisconsin, 1910; Sc. D., Highland Park College, 1917.

Julia Trueman Colpitts. 1913, 1900..Associate Professor of Mathematics  
A. B., Mount Allison University, Canada, 1899; A. M., Cornell University, 1900.

Frank Hamilton Culley. 1915, 1914....Associate Professor of Landscape  
Gardening  
B. Sc., Massachusetts Agricultural College, 1913; M. L. A., Harvard University, 1914.

Henry Ellsworth Ewing. 1916, 1914..Associate Professor of Entomology  
B. A., University of Illinois, 1906; M. A., 1908; Ph. D., Cornell University, 1911.

Evan F. Ferrin. 1913, 1911...Associate Professor of Animal Husbandry  
B. S. in A. H., Iowa State College, 1911.

Genevieve Fisher. 1915, 1914.....Associate Professor of Agricultural  
B. S., Teachers' College, Columbia University, 1914. Education

Chester Charles Fowler. 1913, 1909....Associate Professor of Chemistry  
B. S. in Chem. Eng., University of Illinois, 1909; M. S., 1913; Ph. D., Jefferson Medical College, 1915.

Joseph Edward Guthrie. 1913, 1902.....Associate Professor of Zoology  
B. S., University of Minnesota, 1900; M. S., 1901.

Frank M. Harrington. 1916, 1913....Associate Professor of Horticulture  
B. S., Oregon Agricultural College, 1913.

Kenneth Cole Ikeler. 1915....Associate Professor of Animal Husbandry  
M. E., Pennsylvania Normal, 1909; B. S., Pennsylvania State College, 1913; M. S., Iowa State College, 1914.

William Kunerth. 1916, 1907.....Associate Professor of Physics  
M. A., University of Wisconsin, 1910.

Orren Lloyd-Jones. 1914, 1913..Associate Professor of Animal Husbandry  
B. S., University of Wisconsin, 1908; M. S., 1911; Ph. D., 1913.

Charles August Mann. 1916....Associate Professor of Chemical Engr.  
B. S., University of Wisconsin, 1909; M. S., 1911; Ph. D., 1915.

John Nathan Martin. 1912, 1911.....Associate Professor of Botany  
A. B., Indiana University, 1907; Ph. D., University of Chicago, 1913.

Irving E. Melhus. 1916.....Associate Professor of Plant Pathology  
B. Sc., Iowa State College, 1906; Ph. D., University of Wisconsin, 1912.

Ernest Muchmore Mervine. 1915, 1912....Associate Professor of Agri-  
M. E., University of Lehigh, 1909. cultural Engineering

Helen Monsch. 1915.....Associate Professor of Domestic Science  
B. S., Kansas Agricultural College, 1904; B. S., University of Chicago, 1909; A. M., Columbia University, 1916.

George Chester Morbeck. 1914, 1912....Associate Professor of Forestry  
B. S. in Forestry, Michigan Agricultural College, 1904; M. F., 1915.

Charles Murray. 1913, 1908....Associate Professor of Veterinary Path-  
ology and Bacteriology  
Pe. B., Drake University, 1906; B. S., Iowa State College, 1910;  
D. V. M., 1912.

Charles Sabin Nichols. 1917, 1910..Associate Professor Civil Engineering  
B. C. E., Iowa State College, 1909; C. E., 1914.

Ernest Alanson Pattengill. 1914, 1900..Assoc. Professor of Mathematics  
B. S., Iowa State College, 1897; B. S., Cornell University, 1899.

John Owen Rankin. 1916....Associate Professor of Economic Science  
A. B., Tarkio College, 1904; B. S. A., Iowa State College, 1908; A. M.,  
George Washington University, 1912.

Raemer R. Renshaw. 1914, 1913..Assoc. Professor of Organic Chemistry  
B. S., University of Oregon, 1902; M. S., 1903; Ph. D., Columbia  
University, 1907.

Arthur William Rudnick. 1916, 1913..Associate Professor of Dairying  
B. S., Iowa State College, 1910.

William Elmer Sealock. 1915.....Associate Professor of Agricultural  
A. B., University of Ohio, 1905. Education

Louis Bernard Schmidt. 1911, 1906.....Associate Professor of History  
Ph. B., Cornell College, 1901; A. M., 1906.

Phineas Stevens Shearer. 1914, 1912....Associate Professor of Animal  
B.S. in A. H., Iowa State College, 1912. Husbandry

Roy Eugene Smith. 1914, 1909.....Associate Professor of Soils  
B. S. A., Iowa State College, 1909; M. S., 1911.

George Waddel Snedecor. 1914, 1913..Associate Professor of Mathematics  
B. S., Univ. of Alabama, 1905; M. A., Univ. of Michigan, 1912.

Harold Stiles. 1915, 1914.....Associate Professor of Physics  
A. B., Kenyon College, 1896; A. M., Harvard University, 1904; Ph.  
D., Northwestern University, 1909.

Louis Agassiz Test. 1914, 1913.....Associate Professor of Chemistry  
B. M. E., Purdue University, 1894; A. C., 1896; Ph. D., University of  
Chicago, 1907.

George Ellsworth Thompson. 1915, 1914...Associate Professor of Physics  
A. B., Indiana University, 1909; A. M., 1910; Ph. D., Cornell University, 1913.

George Henry Von Tungeln. 1914, 1913..Assoc. Prof. of Rural Sociology  
Ph. B., Central Westleyan College, 1909; M. A., Northwestern University, 1910.

Henry William Vaughan. 1914, 1913..Assoc. Prof. of Animal Husbandry  
B. S. in Agr., Ohio State University, 1908; M. S. in Agr., 1909.

John Anderson Wilkinson. 1914, 1913....Associate Professor of Physical  
Chemistry and Inorganic Analysis  
B. Sc., Ohio State University, 1903; Ph. D., Cornell University, 1909.

### Assistant Professors

Ross Leon Bancroft. 1915.....Assistant Professor of Soils  
 B. S., University of Wyoming, 1914; M. S., Iowa State College, 1915.

Arthur Laurence Bakke. 1913, 1910.....Assistant Professor of Botany  
 B. S., Iowa State College, 1909; M. S., 1911.

John Hall Buchanan. 1915, 1911.....Assistant Professor of Chemistry  
 B. S., Iowa State College, 1911; M. S., 1915.

Eric Eyre Eastman. 1916, 1913.....Assistant Professor of Soils  
 B. S., Iowa State College, 1913; M. S., 1915.

Sidney Longman Galpin. 1913.....Assistant Professor of Geology  
 A. B., Western Reserve University, 1907; A. M., Cornell University, 1910; Ph. D., 1912.

Heber Howard Gibson. 1915.....Assistant Professor of Agricultural Education  
 A. B., Denison University, 1909; M. A., Columbia University, 1912.

Lester S. Gillette. 1915, 1914....Assistant Professor of Dairy Husbandry  
 B. S. in A. H., Iowa State College, 1913; A. M., University of Missouri, 1914.

Arthur John Hauser. 1916, 1913.....Assistant Professor of Dairying  
 B. S. in Agr., Pennsylvania State College, 1911.

Max Levine. 1914, 1913..Assistant Professor of Bacteriology and Hygiene  
 B. Sc., Massachusetts Institute of Technology, 1912.

Herman A. Scullen. 1914.....Assistant Professor of Zoology  
 A. B., University of Oregon, 1910.

Arthur S. Thurston. 1916.....Assistant Professor of Horticulture  
 B. Sc., Massachusetts Agricultural College, 1914; M. Sc., 1916.

### Instructors

Walter Earl Baker, A. B.....Economic Science, 1916

\*Ada Hayden, B. S., M. S.....Instructor in Botany, 1910

A. Helen Tappan, A. B., A. M., Ph. D.....Instructor in Mathematics, 1915

Alexander Vasey Arragon, A. B., A. M.....Instructor in History, 1915

### AGRICULTURAL EXPERIMENT STATION

Arthur Wayland Dox, B. S., A. M., Ph. D.....Chief in Chemistry

A. T. Erwin, M. S.....Chief in Truck Crops

John Marcus Evvard, M. S.....Assistant Chief in Animal Husbandry

Orson Gunnell Lloyd, B. S., M. S..Assistant Chief in Farm Management

Robert Lorenzo Webster, A. B.....Acting Chief in Entomology

Laurenz Greene, B. S., M. S. A.....Chief in Pomology

Ralph Sydney Potter, A. B., M. S., Ph. D.....Assistant Chief in Soil

\* Absent on leave.

**THE GRADUATE COMMITTEE**

Raymond Allen Pearson, M. S. in Agr., LL.D., D. of Agr., President and Acting Dean.

George Arthur Chaney, B. S., M. S., A. M., Sc. D., Associate Professor of Mathematics, Secretary of the Committee, and Assistant to the Acting Dean.

William Henry Stevenson, A. B., B. S. A., Professor and Head of the Department of Farm Crops and Soils.

Samuel Walker Beyer, B. S., Ph. D., Professor and Head of the Departments of Geology, Mining, and Ceramic Engineering.

William Wallace Dimock, B. Agr., D. V. M., Professor and Head of the Department of Veterinary Pathology and Bacteriology.

Miss Catharine J. MacKay, Diploma, Drexel Institute, Boston Cooking School, Teachers' College, Columbia University, Professor and Dean of the Division of Home Economics.

Louis Hermann Pammel, B. Agr., M. S., Ph. D., Professor and Head of the Department of Botany.

# Graduate Division

PRESIDENT RAYMOND A. PEARSON, Acting Dean

## HISTORY AND ORGANIZATION

The instruction and training of graduate students has been one of the functions of the Iowa State College since its early history. The first degree of Master of Science was conferred in 1877. In 1879 the first degree of Civil Engineer and the first degree of Master of Philosophy were conferred. In early years the department or departments in which the student was registered mapped out the applicant's course and supervised his work. Later, when the divisions of the College had been created, each division controlled its own graduate work. It was not long, however, until the number of graduate students and the diversified character of their work demanded further organization, and a Graduate Committee was appointed to supervise the work of all graduate students. This Committee was in charge until 1913 when the increase in the graduate work made it necessary to perfect still further the organization, and the Graduate Division was established. The Graduate Division is administered by the President of the College as Acting Dean and the Graduate Faculty. Under this organization the graduate work to be pursued in any case is under the Acting Dean, the head of the department, and the professor in charge of the work.

## GENERAL STATEMENT

The Iowa State College of Agriculture and Mechanic Arts offers major and minor work for the degree of Master of Science in the following subjects with special application to the industries: agricultural education, animal husbandry, bacteriology, botany, chemistry, dairying, economics, engineering, farm crops and soils, farm management, forestry, geology, horticulture, mathematics, physics, veterinary anatomy, veterinary pathology, veterinary physiology, and zoology. Graduate instruction leading to the degree of Doctor of Philosophy is also offered in farm crops and soils, animal husbandry, bacteriology, botany, chemistry, dairying, geology, horticulture, and zoology. Additional minor supporting work is offered in other departments to supplement graduate study along technical lines.

## FACULTY

The president, the deans, the heads of the departments in which graduate instruction is authorized, and other members of the faculties who are in immediate charge of graduate instruction are members of the Graduate Faculty.

## AIMS AND METHODS

This is an age of great commercial, scientific, and social interests, and these interests are demanding greater economy, specialization in science, and more humanitarianism. To meet these demands the leaders in the different lines of industry, science, and social affairs must have access to more specialized training than can be secured in four years of study. The man who would be a successful competitor as an expert in any of the different lines of agriculture, or as a skilled chemist, engineer, botanist, bacteriologist, applied economic science expert, or as a teacher or investigator in any of these subjects can by graduate training so increase his efficiency as to open up opportunities otherwise denied him. The development of scientific agriculture, engineering, manufacturing, and all the supporting sciences is dependent upon this training. A greater Iowa, economically and socially, is impossible without it. The Iowa State College has long since realized its responsibility in the further development of the many lines of research work in harmony with the industrial needs of the commonwealth.

Lectures, laboratory work, and seminar methods in which the student is in contact with his research problems are used in the development of the graduate work. The investigative work is shared by instructor and student, and the student acquires the spirit as well as the methods of productive work. To further encourage this spirit of research, provision has been made for the publication of specially meritorious work along some of the lines of investigation of which the institution has charge.

## FEES AND EXPENSES

**Incidental and Janitor Fee:** The regular incidental and janitor fee for the semester is \$12.00, but all students who classify during the classification period, Friday and Saturday before College work begins, will be charged only \$9.00 a semester. Graduate scholars and fellows are required to pay a two-dollar hospital fee, a fee of one dollar for each hour's work up to seven hours, and laboratory fees in their minor only.

**Laboratory Fees.** Laboratory fees at the actual cost of breakage and usage are charged to students, the Treasurer's receipt for the fee being required before the students are admitted to laboratories. Some fees represent charges for mimeograph notes which are furnished at cost; usually when these notes are supplied no text book is required and the fee is in lieu of text book purchase. Deposits are required in some departments to cover the value of equipment loaned to students, and at the end of the term the amount is returned less deduction for loss and breakage. For the amount of the fee in any study the student should refer to the description of studies under the department in which the study is taught. Scholars and fellows are exempt from laboratory fees in their major work.

**Diploma Fee:** For the Master's, Doctor's, or Professional Degrees, \$5.00. This does not include the cost of the Master's or Doctor's hood.

**CLUBS AND SOCIETIES**

In the interest of research and investigation along the lines of applied science and for training in the presentation of results, several clubs and societies have been organized by the instructors and students in the different departments. Among these are the following:

Graduate Club.	I. S. C. Branch of the American Institute of Electrical Engineers.
Iowa Section of American Society of Agronomy.	Chemistry Seminar.
Botany Seminar.	I. S. C. Branch of the American Institute of Mining Engineers.
Physics Seminar.	Civil Engineering Society.
Applied Social Science Club.	I. S. C. Branch of the American Society of Agricultural Engineers.
Mathematics Colloquium.	
Bacteriology Seminar.	

**HONORARY FRATERNITIES**

The following is a list of the Honorary Fraternities of Iowa State College, some of which are maintaining regular programs along lines of research work:

Phi Lambda Upsilon.	Gamma Sigma Delta.
Phi Kappa Phi.	Omicron Nu.
Alpha Zeta.	Delta Sigma Rho.
Tau Beta Pi.	

**ADMISSION**

Graduates of Iowa State College, as well as graduates of other colleges and universities of approved standing, are admitted to the Graduate Division. Before entering upon graduate work in any department, however, the applicant must present evidence that he has had the necessary prerequisite training that will enable him to pursue with profit the courses desired. It should be remembered, also, that admission to graduate work does not necessarily imply admission to candidacy for a degree.

Graduate students wishing to become candidates for the Master's or Doctor's degree will make application in writing to the Dean of the Graduate Division not later than February 1 of the year in which the degree is sought. This application should be approved and signed by the head of the department in which the major subject is offered and by all other members of the faculty under whom the student has done work in support of his candidacy. If the applicant has completed any graduate work in another institution, an authorized statement of the same should be filed with the application for candidacy for degree.

For the purpose of admission to the Graduate Division an approved college or university is one which requires four years of work of collegiate grade for graduation, based upon an entrance requirement of at least fourteen standard high school units.

Candidates for admission to the Graduate Division are required to submit to the Registrar or Dean a complete authorized statement of their

college or university records, including a statement of their entrance credits. A blank application for admission which contains definite instructions regarding admission may be secured from the Registrar or Dean.

When an application has been approved, the Registrar issues a permit to enroll. Upon the payment of fees the candidate is given a receipt which he presents to the Dean, the classifying officer.

Registration should be on regular classification days to avoid payment of extra fee, and it should be completed within two weeks after the opening of a semester to receive full credit for the semester's work.

## CLASSIFICATION

The classification of all *regular* graduate students must be completed in conformity with the following rules:

1. Fifteen credit hours each semester shall constitute full-time graduate work.

2. A major subject allowed by the rules of candidacy for the degree shall be chosen; all major, minor, and supporting work shall be outlined in consultation with the head of the department in which the major is taken.

3. Unless otherwise specially permitted a graduate student shall carry at least one study of strictly graduate grade each semester. In any case at least four hours of strictly graduate work must be completed each year.

4. The course of study as outlined shall not be amended or changed except by the approval of the Dean of the Graduate Division, and any such change shall be in writing and shall be filed with the original course of study.

5. The courses of study as outlined shall be made out in triplicate: one shall be retained in the files of the department in which the major work is taken, one shall be filed in the office of the Dean of the Graduate Division, and one in the office of College Registrar. Each copy shall be signed by the head of the department in which the major work is taken, by the instructor who will have immediate charge of the major line of work, and by the Dean of the Graduate Division.

6. In special cases a *limited* amount of credit may be given in subjects not catalogued as graduate studies where these are taken as minors and bear directly upon the major subjects and are recommended by the professor in charge of the major work and approved by the Dean.

7. Graduate students who are not candidates for an advanced degree are not required to designate a major or a minor subject but may elect their work with a view to their special purpose. Any course of study in the Graduate Division is open for election by such students upon the same conditions that are imposed upon those who are candidates for a degree. If at any time such special students desire to become candidates for an advanced degree, due consideration and credit will be given for work already done.

NOTE: Any deficiency in Modern Language should be made up immediately. See requirements in Modern Language for advanced degrees.

## DEGREES

The higher degrees conferred by the Iowa State College are the Master of Science and Doctor of Philosophy for advanced work in the technical fields especially developed at this college; and the Professional Degrees of Civil Engineer (C. E.), Electrical Engineer (E. E.), Mechanical Engineer (M. E.), Engineer of Mines (E. M.), Ceramic Engineer (Cer. E.), Chemical Engineer (Ch. E.), Agricultural Engineer (A. E.), Master of Agriculture (M. Agr.), and Master of Forestry (M. F.).

### THE MASTER'S DEGREE

The degree of Master of Science may be conferred upon students who have completed work in compliance with the following provisions and requirements:

1. At least one year must be spent in resident work.
2. At least thirty credit hours or the equivalent must be completed, not less than half of which should be completed in this institution.
3. A minimum of twenty credit hours shall be completed in the major work, and a maximum of ten credit hours in the minor work. Minor work is recommended, and it may be taken in the same department in which the major is taken; but both major and minor may not be taken under the same instructor.
4. Major work may, upon special recommendation, be taken in two closely related subjects. In such a case a minor is optional.
5. A satisfactory reading knowledge of French or German must be certified to by the head of the Department of Modern Languages prior to admission to examination. Upon the recommendation of the head of the department some other modern language may be substituted for French or German.
6. Such subjects as are designated as "graduate and advanced undergraduate" or "graduate" will be credited toward the advanced degree. Major work will ordinarily be restricted to graduate subjects. See 6 under Classification.
7. Examination shall be taken on all graduate work including thesis when thesis is required. This examination shall be oral or written as determined by the instructors concerned.
8. Thesis is optional with the department in which the major work is taken. When a thesis is required it should be written in conformity with the following rules:
  - a. The stock should be Brother Jonathan bonk, 8½ x 11. If for any reason this stock is difficult to obtain, it is very desirable that the stock used approximate closely that which is recommended.
  - b. The right and left margins shall each be 1¼ inches. The top margin shall be 1½ inches and the bottom margin shall be 1¾ inches.
  - c. The following specimen title page for the master's thesis may be gotten at the office of the Dean of the Graduate Division.

THE PRODUCTION OF PURE LINES  
IN CEREALS

BY

JOHN ANTHONY KRALL

A THESIS SUBMITTED TO THE GRADUATE FACULTY OF THE  
IOWA STATE COLLEGE OF AGRICULTURE AND ME-  
CHANIC ARTS IN PARTIAL FULFILLMENT OF  
THE REQUIREMENTS FOR THE DEGREE  
OF MASTER OF SCIENCE IN  
AGRONOMY

AMES, IOWA

1916

**THE MASTER'S DEGREE PARTLY IN ABSENTIA**

Any graduate of Iowa State College or other institution of high standing may be permitted to do one-half the required work for the Master's Degree *in absentia* as follows: 1. The applicant must be in residence at this institution during at least three six-weeks summer sessions. 2. During the period of two consecutive years while not in residence at the College the candidate must pursue a course of advanced study previously arranged by the head of the department in which the work is to be done and which has been approved by the Dean of the Graduate Division. This *absentia* work is expected to equal in amount that normally accomplished in three six-weeks summer sessions and is to lie along the line of his major work. Such special students are required to pass examinations on all work done at the College and *in absentia*.

**ADVANCED STANDING**

Graduate students of approved colleges and universities who have completed a portion of the requirements for the Master's or Doctor's degree in the technical lines developed at this institution, may be permitted to enroll as graduate students and finish their work for the desired degree. For the Master's degree at least one year of residence will be required, in which not less than fifteen credit hours of graduate work must be completed. For the Doctor's degree at least one year of residence will be required, in which not less than thirty credit hours of graduate work, inclusive of dissertation, must be completed.

**THE DOCTOR'S DEGREE**

The degree of Doctor of Philosophy may be conferred upon students who complete work in compliance with the following provisions and requirements:

1. Three years of graduate work are required, one of which must be spent at this institution.

2. The degree will be conferred not solely as a result of a faithful study over any period, but for ability to do research work of a scholarly character and for the successful passing of all examinations.

3. Major work shall be taken in one subject, or, in exceptional cases, in two closely related subjects. Two minors shall be taken when only one major is chosen, and one minor shall be taken when two majors are chosen.

4. Minor work shall represent from one-fourth to one-third of the work for the degree.

5. One minor must be taken outside the department in which the major is taken.

6. A reading knowledge of French and German must be certified to by the head of the Department of Modern Languages at least one year prior to final examination.

7. During the last two years of graduate work only such courses as are designated as "graduate" shall be credited on major work.

8. A thesis which is a real contribution to knowledge along some line in which the major is taken must be completed. The rules and regulations governing the printing of Doctors' theses follow:

a. The cover shall be identical in content with the title page.

b. The general format of the thesis is as follows: Dimensions of letter press should approximately be  $4 \times 6\frac{3}{4}$ , to be printed on stock, the exterior dimensions of which should be  $6 \times 9$ , trimmed.

c. If the character of the material in the thesis is such as to require a larger page, then the dimensions of the letter press should approximately be  $5\frac{1}{2} \times 7\frac{3}{4}$ , to be printed on stock, the exterior dimensions of which should be  $8\frac{1}{2} \times 11$ , trimmed.

d. The stock, or paper, on which the thesis is printed should be

Coventry  
Antique Finish Laid  
Watermarked  
 $25 \times 38$  — 60 pounds  
White

e. If, for any reason, this stock should be difficult to obtain, it is desirable that the stock used approximate very closely that which has been recommended.

f. A sample of the following standard title page may be obtained from the office of the Dean of the Graduate Division for the guidance of the printer. Any further details regarding the printing of the thesis should be secured from the Dean of the Graduate Division.

STUDIES ON THE  
PHENOLDISULPHONIC ACID METHOD FOR  
DETERMINING NITRATES IN SOILS

BY  
CHARLES WESLEY DAVIS

A DISSERTATION SUBMITTED TO THE GRADUATE FACULTY OF  
THE IOWA STATE COLLEGE OF AGRICULTURE AND ME-  
CHANIC ARTS IN PARTIAL FULFILLMENT OF  
THE REQUIREMENTS FOR THE DEGREE  
OF DOCTOR OF PHILOSOPHY

NO. 2

REPRINTED FROM THE  
JOURNAL OF INDUSTRIAL AND ENGINEERING CHEMISTRY  
MARCH, 1917

9. Not later than April 1st of the academic year in which the degree is sought, the candidate should have his thesis approved by the head of the department in which the major work has been taken, and submitted in typewritten form to the Dean of the Graduate Division. May 1st is the latest date for the transmittal of the thesis.

10. Publication of the thesis by the candidate or by a scientific journal is required. In either case the degree will not be conferred until two type-written copies of the thesis have been deposited in the library and a financial guarantee that fifty printed copies in approved form will also be deposited in the library. Reprints from standard journals are acceptable when printed in conformity with the above rules and regulations.

11. The Dean of the Graduate Division shall appoint for each candidate an examining committee composed of five members, including the professors in charge of the major and minor work, the chairman of which shall be the professor in charge of the student's major work. The Dean shall also designate the time and place for the examination, which may be either oral or written or both, over the fields of the major and first minor. In case a second minor is chosen, the examinations over it may be waived if the candidate's standing in it is satisfactory.

#### PROFESSIONAL DEGREES

Application for admission to candidacy for a professional degree in *Engineering* should be made to the Dean of Engineering prior to the beginning of the second semester of the year in which the degree is sought. The requirements may be met in any one of the three following ways:

1. Graduation from a regular four-year course in engineering, one year of resident study approved by the engineering faculty, at least one year of experience in a responsible professional position, and the preparation of a satisfactory thesis.

2. Graduation from a regular four-year course in engineering, at least five years of experience in a responsible professional position, and the preparation of a satisfactory thesis.

3. Graduation from a regular five-year course in engineering, at least one year of successful professional experience, and the preparation of a satisfactory thesis.

In *Agriculture and Engineering* the requirements for the degree of Agricultural Engineer are the same as those for the professional degrees in agriculture and engineering, and the candidate must be recommended by the faculties of both the Agricultural and Engineering Divisions.

In *Agriculture* the professional degree of Master of Agriculture is granted on the initiative of the faculty of the Division of Agriculture. The completion of a standard collegiate course in agriculture followed by not less than five years of eminently successful experience in some phase of practical or professional agriculture, and the presentation of an acceptable thesis are prerequisite.

It is the policy of the College to confer professional degrees only in cases of superior professional attainments, and then only on those who are present at Commencement.

## FELLOWSHIPS AND SCHOLARSHIPS

For the promotion of graduate study and research the Board of Education has established at Iowa State College a number of fellowships and scholarships. Application blanks may be obtained from the Dean of the Graduate Division, and when filled out should be filed in his office.

Scholarships are given to holders of a baccalaureate degree and carry with them a stipend of two hundred dollars payable in ten equal payments with the remission of tuition. All scholars pay a two dollar hospital fee, a fee of one dollar for each hour's work up to seven hours, and laboratory fees in their minor subjects only. Scholars are required to do at least three hours teaching a week or the equivalent.

Teaching Fellowships are open to graduates of approved institutions and carry with them a stipend of four hundred dollars with the remission of tuition. Teaching Fellows are required to do at least five hours of teaching a week or its equivalent. The fees for Fellows are the same as those for Scholars.

Junior and Senior Research Fellowships are open to graduates of approved institutions and have for their object the encouragement of research work. Junior Research Fellowships may be held during the first year of graduate study and carry with them a stipend of three hundred dollars with the remission of tuition. Senior Research Fellowships carry with them a stipend of five hundred dollars and are ordinarily not awarded except to those who have had at least one year of graduate study or research experience. Research Fellows in the experiment stations shall observe experiment station hours throughout the college year, except for the time given to minor work. The fees for all Fellows are the same as those for Scholars.

Full resident credit may be given for graduate work to holders of scholarships, and of teaching and research fellowships.

## GRADUATE STUDY BY MEMBERS OF STAFFS

The members of the instructional and investigational force of the rank of instructor or assistant are permitted to do graduate work. Those on half-time employment may receive not to exceed two-thirds time credit, and those on full time may receive not to exceed one-fourth time credit. All adjustments as to the amount of credit to be allowed shall be made between the Head of the Department in which the work is taken and the Dean of the Graduate Division.

Members of the Experiment Station whose ranks correspond to those of instructors or assistants in the College may carry a limited amount of graduate work subject to the approval of the President.

**DEPARTMENTS OFFERING GRADUATE INSTRUCTION****Agricultural Education**

Professor Wilson; Associate Professors Sealock, Fisher; Assistant Professor Gibson

The department offers to graduate students minor work only, except in special cases when major work limited to technical agricultural subjects may be taken.

**SUBJECTS FOR GRADUATES**

**20. Research in Education.** The field of agricultural education supplies many problems for the advanced student of education. (a) Courses of study in Agriculture: The organizations of Secondary Courses in Agriculture on a problem or vocational basis, and adapted to local conditions. (b) Vocational and Industrial Surveys: Surveys that will form an intelligent basis for the organization of vocational courses in agriculture and home economics. *Hours by appointment.* PROFESSOR WILSON

**SUBJECTS FOR GRADUATES AND ADVANCED UNDERGRADUATES**

Educational History; School Administration; Principles of Education; Development of Industrial High School; Rural Education; Public Education; Training in Teaching Home Economics; Observation; Training in Teaching Agriculture; Methods of Agricultural Extension Teaching. For descriptions of these subjects see page 95 in General Catalogue.

**AGRICULTURAL ENGINEERING**

Professor Costelloe; Associate Professor Mervine

The department offers major work for the degree of Master of Science in Agricultural Engineering along the lines of farm machinery, farm power, drainage, irrigation, rural sanitation, and farm structures; and minor work for students selecting major work in other departments.

**SUBJECTS FOR GRADUATES**

**34. Agricultural Engineering.** Advanced work in drainage, irrigation, farm structures, farm power, or farm machinery. Ample facilities are available for advanced study and research. *Credit as arranged.*

PROFESSOR COSTELLOE and ASSOCIATE PROFESSOR MERVINE

**SUBJECTS FOR GRADUATES AND ADVANCED UNDERGRADUATES**

Farm Machinery; Farm Motors; Rural Sanitation; Farm Structures; Drainage Engineering; Irrigation; Gas Engines and Tractors.

For descriptions of these subjects see page 104 of General Catalogue.

For the requirements for the professional degree of Agricultural Engineer see page 20.

**Animal Husbandry**

Professors Pew, Turpin; Associate Professors Vaughan, Lloyd-Jones, Shearer, Ferrin, Ikeler; Assistant Chief Evvard; Assistant Professor Gillette

The department offers major and minor work for the Master's degree

along the lines of animal nutrition and feeding, animal breeding, live stock management, dairy husbandry, and poultry husbandry, and major and minor work for the Doctor's degree along the lines of nutrition, genetics, and dairy husbandry.

The student who enters upon graduate work in animal husbandry must have, in addition to a Bachelor's degree, a general knowledge of zoology, inorganic and organic chemistry, and he must be qualified by training to undertake the special line of work which he elects. The major work must be selected from one of the above lines and a suitable thesis written. Minor subjects may be elected in this or another department.

#### SUBJECTS FOR GRADUATES

65. **Research in Animal Breeding.** Heredity and its related problems offer a large field for experimental research. *Credit 3 to 10 hours per semester.*

ASSOCIATE PROFESSOR LLOYD-JONES

66. **Advanced Animal Nutrition.** Feeding, care, and management of live stock; especial emphasis being placed on the study of experimental methods and of research work previously done. Practical and fundamental problems will be worked out. Practical laboratories and lectures are given. *Credit 3 to 10 hours per semester.*

PROFESSOR PEW; ASSOCIATE PROFESSORS IKELER, SHEARER, EVVARD

67. **Research in Dairy Husbandry.** Advanced study of the dairy breeds; milk production and herd management. *Credit 3 to 10 hours per semester.*

ASSISTANT PROFESSOR GILLETTE

68. **Research in Poultry Husbandry.** Incubation, brooding, feeding, breeding, marketing and study of the principles and practices of successful management of flocks. *Credit 3 to 10 hours per semester.*

PROFESSOR TURPIN

70. **Problems of Heredity and Breeding.** Seminar. Weekly conferences in which current work in the experimental study of heredity and special topics are discussed. *Credit 1 hour per semester.*

ASSOCIATE PROFESSOR LLOYD-JONES

#### SUBJECTS FOR GRADUATES AND ADVANCED UNDERGRADUATES

Studies in Live Stock Production, Feeding, Management, and Judging; studies in Milk and Wool Production; Herd Book Study; Animal Nutrition; Market and Breeding Types of Poultry; Genetics. For descriptions of these subjects see page 118 of General Catalogue.

### ARCHITECTURAL ENGINEERING AND RURAL STRUCTURES

Professor Allen Homes Kimball

The department offers major and minor work leading to the degree of Master of Science in Architectural Engineering.

#### SUBJECTS FOR GRADUATES

1038. **Advanced Design.** Advanced work in industrial and rural building practice; special advanced work in steel, masonry, and frame

building construction. *Open for major or minor subjects. Details of classification specially arranged.*

PROFESSOR KIMBALL

SUBJECTS FOR GRADUATES AND ADVANCED UNDERGRADUATES

Special Interior Design; Advanced Design; Seminars; Elements of Architecture; History of Architecture; Industrial Structures; Sanitation of Buildings; Estimating; Elements of Contracting; Rural Design. For description see page 126 in General Catalogue.

**Bacteriology and Hygiene**

Professors Buchanan, Brown, Hammer; Associate Professor Murray,  
Assistant Professor Levine

Major and minor work leading to the degrees of Master of Science and Doctor of Philosophy are offered in those phases of bacteriology which have important relations to agriculture, home economics, engineering, veterinary medicine, and the industries.

The student who elects his major in any field of bacteriology should present undergraduate credits in organic chemistry, one semester of physics, the equivalent of Course 1 in Bacteriology, and an elementary course in the line in which he expects to major. Ordinarily a student must do two-thirds of his work in one of the lines of bacteriology above mentioned.

SUBJECTS FOR GRADUATES

30. **Research in General Systematic Bacteriology.** For graduate students. *Either Sem. Prerequisites 1 and 5 or equivalent; fee \$5.00.*

PROFESSOR BUCHANAN

70. **Immunity and Serum Therapy.** Continuation of 61 for graduate students. *Recitations, assigned readings, conferences, and laboratories as arranged; credit 3; fee \$5.00.* ASSOCIATE PROFESSOR MURRAY

71. **Pathogenic Bacteriology,** Continuation of 50 for graduate students. *Recitations, assigned readings, conferences, and laboratories as arranged; credit 3; fee \$5.00.* ASSOCIATE PROFESSOR MURRAY

72. **Research in Pathogenic Bacteriology.** For graduate students. *Either Sem. Prerequisites 1 and 60 or equivalent; fee \$5.00.*

PROFESSOR BUCHANAN or ASSOCIATE PROFESSOR MURRAY

141. **Research in Dairy Bacteriology.** For graduate students. *Either Sem. Prerequisite 101.*

PROFESSOR HAMMER

171. **Research in Sanitary Bacteriology or Hygiene.** For graduate students. *Either Sem. Prerequisites 1 and 155 or equivalent; fee \$5.00.*

ASSISTANT PROFESSOR LEVINE

231. **Research in Soil Bacteriology.** Same as Soils 231. Bacterial activities in the soil. Field, greenhouse, or laboratory experiments. The classification of soil bacteria. Molds, protozoa, and higher bacteria; occurrence and action in soils. General study of the relation of soil organisms to fertility. *Either Sem. Prerequisite 201; credit 5 or 10; fee \$5.00.*

PROFESSOR BROWN

232. **Conference in Soil Bacteriology.** Same as Soils 232. Reports and discussion on current investigations. *Either Sem.* PROFESSOR BROWN

260. **Research in Household Bacteriology.** For graduate students.  
*Credit as arranged.* PROFESSOR BUCHANAN

SUBJECTS FOR GRADUATES AND ADVANCED UNDERGRADUATES

Agricultural Bacteriology; Advanced Agricultural Bacteriology; Seminars; Veterinary Pathogenic Bacteriology; Immunity and Serum Therapy; Zymotecnique and Household Bacteriology; Dairy Bacteriology; Industrial Sanitary Bacteriology. For descriptions of these subjects see page 132 in the General Catalogue.

**Botany**

Professor Pammel; Associate Professors Martin, Melhus; Assistant Professor Bakke; Instructor Hayden

The department offers major and minor work for the degrees, Master of Science and Doctor of Philosophy in those fields of Botany which find their application in agriculture, horticulture, forestry, and the industries. For this purpose graduate and research work in vegetable pathology, morphology, physiology, systematic and economic botany are offered.

Some of the research work receiving special attention at this time is alfalfa and clover pollination studies, the distribution of forest trees, transpiration of plants, honey plants of Iowa, rust investigations, fusarium disease of corn, crown gall, cabbage yellows, clover and alfalfa diseases, and corn root moulds.

SUBJECTS FOR GRADUATES

103. **Cytology.** How to kill, imbed, section, and stain material; a knowledge of the various stages in the development of the pistils and stamens of flowers; the investigation of some problems which will give skill in the use of the above processes. *Either Sem. Prerequisites 161, 127, 268; recitations 2 or 4; labs. 3 or 6, 3 hr.; credit 5 or 10; fee \$3.00 to \$5.00.*

ASSOCIATE PROFESSOR MARTIN

119. **Morphology of Farm Crops.** Root, stem, seed, and floral structures of corn, wheat, oats, clover, alfalfa, etc. Designed for students interested in problems of plant breeding, lodging of grains, sterility of plants, and development of seed coats as related to the germination of seeds. *Fall Sem. Prerequisite 103 or 105; recitation 1; labs. 2, 2 hrs.; credit 2½; fee \$2.00.*

ASSOCIATE PROFESSOR MARTIN

193. **General Morphology.** Especially in development and embryogeny. Anatomy of seeds or some special organs of plants. *Either Sem. Prerequisite 161, 124; recitations 2; lab. 1, 2 hr.; credit 2½; fee \$2.00.*

ASSOCIATE PROFESSOR MARTIN

194. **Advanced Course in Thallophytes.** The morphology of some particular group of lower forms. *Either Sem. Prerequisite 268 or 189; recitations 2 or 4; labs. 3 or 6, 3 hr.; credit 5 or 10; fee \$3.00 or \$5.00.*

MISS HAYDEN

195. **Advanced Morphology of the Flowering Plants.** *Either Sem. Prerequisites 268 and 189, and Zool. 16, 46, or 52, and Bact. 1; recitations 2 or 4; lab. 3 or 6, 3 hr.; credit 5 or 10; fee \$3.00 or \$5.00.*

ASSOCIATE PROFESSOR MARTIN

291. **Plant Chemics.** Growth and movement. Continuation of 290. *6th or 8th Sem. Prerequisite 290; recitation 3; lab. 2, 3 hr.; credit 5; fee \$5.00.*

ASSISTANT PROFESSOR BAKKE

292. **Physiology.** Specific problems in plant chemics, plant physics, or growth and movement. *Either Sem. Prerequisites 268, Chem. 351, Phys. 205, Bact. 1; recitation 1; labs. 2 or 4, 3 hrs.; credit 3 or 5; fee \$3.00 or \$5.00.*

ASSISTANT PROFESSOR BAKKE

#### PLANT PATHOLOGY

304. **Plant Pathology.** Specific problems in the diseases of plants. *Either Sem. Prerequisites 161, or 127, 128, 470, 189, 366, 268, Bact. 1, Zool. 2, 3, 304; recitations 2 or 4; labs. 3 or 6, 3 hr.; credit 5 or 10; fee \$3.00 or \$5.00.*

ASSOCIATE PROFESSOR MELHUS

309. **Advanced Plant Pathology.** Cultural, physiological, histological and cytological technique as employed in plant pathology. Laboratory practice in isolation of parasites, germination, inoculation, and carrying stock cultures of plant parasites on the living host in the greenhouse. *8th Sem. Prerequisites 308, 365, or 366; recitation 1; labs. 2, 3 hr.; credit 3; fee \$5.00.*

ASSOCIATE PROFESSOR MELHUS

310. **Disease Control.** Principles and practice of disease control. Includes discussion of exclusion, eradication, protection by fungicides, and methods of selection for disease resistance. The composition, preparation, and methods of application of fungicides and their action on host and parasite. *8th Sem. Prerequisite 308, 365, or 366; recitation 1; lab. 1, 3 hr.; credit 2; fee \$4.00.*

ASSOCIATE PROFESSOR MELHUS

496a. **Research Systematic Botany.** Flowering plants or thallophytes, especially plants of economic importance and those in some way related to agricultural and horticultural problems. *Either Sem. Prerequisites 161, 127, 128, 189, or 268, Zool. 2, 3, Bact. 1; recitations 2 or 4; labs. 3 or 6, 3 hr.; credit 5 or 10; fee \$3.00 or \$5.00.*

PROFESSOR PAMMEL

496b. **Advanced Conference in Systematic Botany.** Some special group of spermatophytes. *7th Sem. Prerequisites 161 or 127, and 470; recitation 1; lab. 6 hrs.; credit 3; fee \$3.00.*

PROFESSOR PAMMEL

498. **Advanced Mycology.** Some specific group of the fungi. *Either Sem. Prerequisite 497; recitation 1; labs. 2, 3 hr.; credit 3; fee \$4.00.*

ASSOCIATE PROFESSOR MELHUS

#### ECONOMIC BOTANY

500. **Seed Testing.** Impurities of seeds and adulterations, as well as the structures of the seeds. *Either Sem. Prerequisites 161, 127, 128, 470, or 560; recitations 2 or 4; labs. 3 or 6, 3 hr.; credit 5 or 10; fee \$3.00 or \$5.00.*

PROFESSOR PAMMEL

501. **Poisonous Plants.** For those pursuing some minor work in chemistry, and those who have some knowledge of general bacteriology. *Either Sem. Prerequisites 161, 109, 470, 516, 268, Chem. 104, 351, Bact. 1, Vet. Phys. 322, 634, 527; recitations 2 or 4; labs. 3 or 6, 3 hr.; credit 5 or 10; fee \$3.00 or \$5.00.*

PROFESSOR PAMMEL

597. **Applied Botany.** Food plants of man, their economic uses, and their distribution with reference to climatic conditions. *Either Sem. Prerequisites 161, 127, 128, 470, or 366, Econ. 110, Hist. 20; recitations 2 or 4; labs. 3 or 6, 3 hr.; credit 5 or 10; fee \$3.00 or \$5.00.*

PROFESSOR PAMMEL, MISS HAYDEN

599. **Microscopical Examination of Foods.** Particular forms of food from a microscopical standpoint. *Either Sem. Prerequisites 161, or 127 or 128, Chem. 352, 353, 303; recitations 2 or 4; labs. 3 or 6, 3 hr.; credit 5 or 10; fee \$3.00 or \$5.00.*

PROFESSOR PAMMEL

#### HISTORY, SEMINAR, AND THESIS

602. **Thesis.** A thesis embodying the results of some special work must be presented four weeks before the close of the year. Candidates in major and minor work must be generally well informed on botanical subjects and should be familiar with botanical literature. *Credit 5 or 10; fee \$5.00.* PROFESSOR PAMMEL; ASSOCIATE PROFESSORS MARTIN, MELHUS

#### SUBJECTS FOR GRADUATES AND ADVANCED UNDERGRADUATES

Plant Embryogeny; Botany of Weeds; Evolution of Plants; General and Experimental Morphology; Methods of Histology; Cytology and Methods of Histology; Fungi; Physiology, Ecology, Agrostology; Systematic Botany; Dendrology; Mycology; Plant Pathology; Range and Poisonous Plants; Botanical Seminars; Microscopical Examination of Foods; Seed Testing; Poisonous Plants; Pathological Physiology; Economic Botany. For descriptions see page 138 of General Catalogue.

### Ceramics

Professors Beyer, Staley; Assistant Professor Galpin

The department offers major and minor work for the degree of Master of Science along the lines of ceramic technology of crude and fine clay products, the technology of glass and enamel making, the geology of clays and ceramic materials, microscopic study of clays, and ceramic materials and cement making.

#### SUBJECTS FOR GRADUATES

912. **Advanced Ceramic Technology.** Research problems in manufacture of crude and fine clay products and wares; investigations of glass making and enameling; geology of clays and other ceramic materials; microscopic study of raw ceramic materials and finished products; special problems in manufacture of artificial cements. Special ceramics building and laboratories established by the legislature on demand of the clay industries of the state, provide complete equipment for such advanced work. The Iowa field offers excellent opportunities for highly trained ceramic engineers. *Open for major or minor subjects. Details of classification specially arranged for the individual student. Proper fees charged for laboratory work chosen.*

PROFESSORS BEYER, STALEY; ASSISTANT PROFESSOR GALPIN

1014. **Advanced Ceramic Technology.** Continuation of 912. *Credit as arranged.* PROFESSOR STALEY AND ASSISTANT PROFESSOR GALPIN

#### SUBJECTS FOR GRADUATES AND ADVANCED UNDERGRADUATES

Application of Physical Chemistry to the Silicate Industries; Ceramics; Thesis; Handmade Pottery; Special Problems in Ceramic Technology; and Advanced Special Problems in Ceramic Technology. For descriptions see page 150 in General Catalogue. For the professional degree of Ceramic Engineer see page 20.

## Chemical Engineering

Professors Beyer, Coover; Associate Professor Mann

The department offers major and minor work for the Master's degree in any of the different lines of work in chemical engineering.

The Chemical and Engineering Departments are provided with facilities for investigation of manufacturing problems and for conducting industrial research according to a practical system of coöperation between science and industry.

### SUBJECTS FOR GRADUATES

**Research in Manufacturing Problems.** *2 to 4 credits.*

ASSOCIATE PROFESSOR MANN

**Research in Applied Electrochemistry.** *3 to 5 credits.*

ASSOCIATE PROFESSOR MANN

### SUBJECTS FOR GRADUATES AND ADVANCED UNDERGRADUATES

Municipal Chemistry; Chemical Machinery; Industrial Chemistry; Applied Electrochemistry; Chemical Manufacture; Chemistry of Manufacture of Foods. For descriptions of these subjects see page 165 in General Catalogue.

For the requirements for the professional degree of Chemical Engineer see page 20.

## Chemistry

College Department Staff: Professor Coover; Associate Professors Fowler, Test, Wilkinson, Renshaw, Mann; Assistant Professors Buchanan, Brown. Agricultural Experiment Station  
Staff: Chief Dox, Engineering Experiment Station Staff: Chief Coye.

The Department of Chemistry offers major and minor work for the Master's and Doctor's degrees in those fields of chemistry applicable to agriculture, engineering, home economics, veterinary medicine, and the industries.

In the Agricultural Experiment Station thesis work is offered in agricultural and biological chemistry. In the Engineering Experiment Station thesis work is offered in industrial chemistry and the chemistry of road materials.

### SUBJECTS FOR GRADUATES

**121. Advanced Inorganic Chemistry.** Selected topics: atomic theory, periodic-law, theories of valency, reactions in non-aqueous solvents, etc. Laboratory work: special methods illustrated by the preparation of typical substances. Lectures or laboratory may be taken separately. *Fall Sem. Prerequisite, 205 as parallel; lectures 3; lab. 3, 3 hr.; credit 3 or 6; deposit \$10.00 if laboratory is taken.* ASSOCIATE PROFESSOR TEST

**122. Advanced Inorganic Chemistry.** Continuation of 121. Lectures or laboratory may be taken separately. *Spring Sem. Prerequisite 205; lectures 3; lab. 3, 3 hr.; credit 3 or 6; deposit \$10.00 if laboratory is taken.*

ASSOCIATE PROFESSOR TEST

**215. Advanced Applied Physical Chemistry.** Special topics. A discussion of chemistry of industrial processes based upon the phase rule and the theorem of LeChatelier. Lectures, conferences, and laboratory work. Lectures may be taken without laboratory. *Fall Sem.* *Prerequisite 208; lectures 2; labs. 3, 3 hr.; credit 2 or 5; deposit \$10.00 if laboratory is taken.*

ASSOCIATE PROFESSOR WILKINSON

**216. Advanced Applied Physical Chemistry.** Continuation of 215. *Spring Sem.* *Lectures 2; labs. 3, 3 hr.; credit 2 or 5; deposit \$10.00 if laboratory is taken.*

ASSOCIATE PROFESSOR WILKINSON

**163. Advanced Quantitative Analysis.** A systematic study of quantitative separations including the rarer elements. *5th Sem.* *Prerequisite 162; lectures 1; labs. 3 or 6, 3 hr.; credit 4 or 7; deposit \$10.00.*

ASSOCIATE PROFESSOR WILKINSON

**164. Advanced Quantitative Analysis.** Continuation of 163. *6th Sem.* *Lectures 1; labs. 3 or 6, 3 hr.; credit 4 or 7; deposit \$10.00.*

ASSOCIATE PROFESSOR WILKINSON

**267. Critical Study of Methods and Apparatus for the Preparation of Carbon Compounds.** Extraction, distillation, filtration, etc. Apparatus designing, reduction, oxidation, nitronation, sulfonation, esterification, etc. *5th Sem.* *Prerequisite 252; lectures and demonstrations 2; credit 2.*

ASSOCIATE PROFESSOR RENSHAW

**268. Special Topics in Applied Organic Chemistry.** Three or more topics selected from the following; theories of reactions, the carbohydrates, proteins, terpenes, heterocyclic compounds, alkaloids, and dyestuffs. *6th Sem.* *Prerequisite 252; lectures 2; credit 2.*

ASSOCIATE PROFESSOR RENSHAW

**271. Advanced Applied Organic Chemistry.** A laboratory study in the synthesis and preparation of a number of carbon compounds of interest in the arts and industries, including dyestuffs, perfumes, and drugs. Opportunity will be given for gaining experience in a variety of laboratory methods. *Fall Sem.* *Prerequisite 252; labs. 3 to 5, 3 hr.; credit 3 to 5; deposit \$10.00.*

ASSOCIATE PROFESSOR RENSHAW

**272. Advanced Applied Organic Chemistry.** Continuation of 271. *Spring Sem.* *Prerequisite 265; labs. 3 to 5, 3 hr.; credit 3 to 5; deposit \$10.00.*

ASSOCIATE PROFESSOR RENSHAW

**303. Food Analysis.** Methods of analysis of animal and vegetable foods, including tests for adulterants, preservatives, and coloring matters; and methods of organic analysis. A discussion of food legislation and standards of purity. *5th or 6th Sem.* *Prerequisite 352 or 376; lectures 2; labs. 1½ or 4½, 2 hr.; credit 3 or 5; deposit \$7.50 or \$10.00.*

PROFESSOR COOVER AND ASSISTANT PROFESSOR BUCHANAN

**304. Advanced Food Analysis.** Continuation of 303. *6th Sem.* *Prerequisites 303 and 252; lectures 2; labs. 1½ or 4½, 2 hr.; credit 3 or 5; deposit \$7.50 or \$10.00. Offered in 1918-1919.*

PROFESSOR COOVER AND ASSISTANT PROFESSOR BUCHANAN

**365. Analysis of Soils and Fertilizers.** Designed especially for those students in agronomy or animal husbandry who wish to continue the work

begun in 352 in fertilizers and soil analysis. *5th Sem.* *Prerequisite 352; lectures 2; labs. 3, 2 hr.; credit 4; deposit \$10.00.*

PROFESSOR COOVER AND ASSISTANT PROFESSOR BUCHANAN

366. **Chemistry of Soils.** The most recent investigational work on soils. Research problems. *6th Sem.* *Prerequisite 162, 365, 252; lectures 2; lab. 5, 2 hr.; credit 5½; deposit \$10.00*

PROFESSOR COOVER AND ASSISTANT PROFESSOR BUCHANAN

401. **Physiological Chemistry and Nutrition.** For students who desire to obtain a thorough grounding in the principles of physiological chemistry and nutrition. In conjunction with Chemistry 402 it covers fully the chemistry of digestion, assimilation, and metabolism of the organic and inorganic constituents of the food, and the secretions and excretions of the animal body with special reference to their normal and pathological significance. *5th Sem.* *Prerequisite Organic Chem. and Quantitative Analysis; lectures 3; labs. 2, 3 hr.; credit 3 to 5; deposit \$7.50.*

ASSOCIATE PROFESSOR FOWLER

402. **Physiological Chemistry and Nutrition.** Continuation of 401. *6th Sem.* *Lectures 3; labs. 2, 3 hr. or 3, 2 hr.; credit 3 to 5; deposit \$7.50.*

ASSOCIATE PROFESSOR FOWLER

415. **Special Problems.** Advanced instruction in physiological chemistry along lines closely associated to dietetics, experimental veterinary medicine, animal nutrition, bacteriology, etc. *7th or 8th Sem. or both; prerequisite 402 or 420; conference 1; lab. 2, 3 hr. or more; credit 3 or more; deposit \$7.50 or more.*

ASSOCIATE PROFESSOR FOWLER

420. **Metabolism and Human Nutrition.** Nutrition of the human body with special reference to dietetic problems. *6th Sem.* *Prerequisite 403; lectures 3; labs. 2, 3 hr. or 3, 2 hr.; credit 3 to 5; deposit \$7.50.*

ASSOCIATE PROFESSOR FOWLER

801. **Research.** Research work for graduate students is offered in the following subjects:

- a. Applied Inorganic Chemistry, ASSOCIATE PROFESSOR TEST and ASSISTANT PROFESSOR BROWN.
- b. Analytical Chemistry, ASSOCIATE PROFESSOR WILKINSON.
- c. Applied Physical Chemistry, ASSOCIATE PROFESSOR WILKINSON.
- d. Applied Organic Chemistry, ASSOCIATE PROFESSOR RENSHAW.
- e. Organic Analysis or Food Analysis, PROFESSOR COOVER and ASSISTANT PROFESSOR BUCHANAN.
- f. Agricultural Chemistry, PROFESSOR COOVER.
- g. Physiological Chemistry and Nutrition, ASSOCIATE PROFESSOR FOWLER.

*Either Sem.*

#### SUBJECTS FOR GRADUATES AND ADVANCED UNDERGRADUATES

Applied Physical Chemistry; Electro-chemistry; Analysis of Carbon Compounds; Manufacture of Fine Organic Chemicals; Applied Organic Chemistry; Food Analysis; Dairy Chemistry; Sanitary Chemistry; Agricultural Chemistry; Physiological Chemistry; Research in Metabolism; Industrial Chemistry; Chemical Machinery; and Municipal Chemistry; Textiles; Animal and Plant Chemistry. For description see page 158 in General Catalogue.

## Civil Engineering

Professors Kirkham, King, Agg; Associate Professors Nichols, Crum

The department offers major work for the degree of Master of Science in Civil Engineering along the lines of masonry structures and experimental engineering, railway engineering, structural engineering, hydraulic and sanitary engineering, masonry design, highway engineering; and minor and supporting work in the other departments of the Engineering, Agricultural, and Industrial Science Divisions. Students may therefore major in civil engineering and minor in any department of the Agricultural and Industrial Science Divisions which offers a correlated line of work, and vice versa.

### SUBJECTS FOR GRADUATES

1108. **Railway Engineering.** Advanced work in railway signaling, railway design, railway economics, and railway administration and operation. PROFESSOR KING

1109. **Structural Engineering.** Advanced work in the design of all types of concrete and steel structures. PROFESSOR KIRKHAM

1110. **Experimental Engineering.** Advanced work in experimental hydraulics, concrete and concrete materials, iron and steel, and other materials of construction. ASSOCIATE PROFESSOR CRUM

1111. **Water Supply and Sewage Disposal.** Preparation of plans and specifications for water and sewage purification works, including necessary coördinate work in Chemistry and Bacteriology; special investigations in coöperation with the Departments of Chemistry and Bacteriology, and with the Iowa State Board of Health.

1112. **Highway Engineering.** The traffic census as a factor in the design of roads; the traffic zone as a factor in the selection of routes for improvement; advanced pavement design; the relation between types of roads and methods of financing; advanced work in bituminous and non-bituminous road materials testing. PROFESSOR AGG

### SUBJECTS FOR GRADUATES AND ADVANCED UNDERGRADUATES

Water Purification; Sewage Treatment and Municipal Wastes Disposal; Elements of City Planning; Seminars; Water Supply; Railway Design; Railway Operation; Structural Engineering; Road Materials; Experimental Work in Civil Engineering; Masonry Design; Highway Engineering; Roads and Pavement Design; Hydraulic Design; Railway Engineering; Sanitary Design; Water Power; Highway Design; Hydrology; Advanced Reinforced Concrete Design; History, Composition and Uses of Concrete. For description see page 175 in General Catalogue.

For the professional degree of Civil Engineer see page 20.

## Dairying

Professors Mortensen, Hammer; Associate Professor Rudnick; Assistant Professor Hauser

The Department of Dairying offers major and minor work for the Master's degree along the lines of management of dairy plants, dairy bacteriology, and creamery products. In correlation with the fundamental

sciences the department also offers major and minor work for the Doctor's degree in management of dairy plants and dairy bacteriology.

#### SUBJECTS FOR GRADUATES

31. **Research in Buttermaking.** Cream ripening; pasteurization; churning and storing of butter; chemical and bacteriological changes involved in these various processes.

PROFESSOR MORTENSEN, ASSOCIATE PROFESSOR RUDNICK

32. **Research in Ice Cream Making.** Composition of ice creams, fillers, and their influences on quality and yield; homogenization, pasteurization, and storage of cream as related to ice cream manufacture.

PROFESSOR MORTENSEN

33. **Research in Management of Dairy Plants.** Economic manufacture and marketing of dairy products. Work carried on in connection with the college and commercial plants of the state.

PROFESSOR MORTENSEN, ASSOCIATE PROFESSOR RUDNICK

34. **Research in Market Milk.** The effect of various methods of handling on the quality of market milk and cream.

PROFESSOR HAMMER, ASSISTANT PROFESSOR HAUSER

50. **Conference in Dairying.** Reports and discussion on current investigations. Required of graduate students. PROFESSOR HAMMER

141. **Research in Dairy Bacteriology.** Same as Bact. 141. For graduate students only. *Either Sem. Prerequisite 101.* PROFESSOR HAMMER

#### SUBJECTS FOR GRADUATES AND ADVANCED UNDERGRADUATES

Factory Management; Fancy Ice Creams and Ices; Judging Dairy Products; Milk Testing and Inspection; Seminars; Market Milk; Dairy Bacteriology; Special Dairy Bacteriology, Ice Cream Making, Butter Making, and Creamery Management; Cheese Making; Thesis; Domestic Dairying; Advanced Dairy Bacteriology. For descriptions of these subjects see page 187 in General Catalogue.

### Economic Science

#### APPLIED ECONOMICS AND SOCIAL SCIENCE

Professor Brindley; Associate Professors Von Tungeln and Rankin; Instructor Baker

The Department of Economic Science offers major and minor work for the Master's degree in those fields of Economic Science applicable to agriculture, engineering, home economics, veterinary medicine, and the industries.

The different libraries of the college contain many of the best reference works, journals, magazines, and government publications bearing on agricultural economics, engineering economics, and rural sociology. Research work in rural sociology is carried on during the summer.

#### SUBJECTS FOR GRADUATES

45. **Advanced Economic and Social Principles.** Conference subject, primarily for graduates. *10th Sem. Credit 2.*

PROFESSOR BRINDLEY; ASSOCIATE PROFESSORS RANKIN and VON TUNGELEN

**540. Thesis.** Thesis and research work that may be credited as partial requirements for advanced degrees. Directed by the members of the Department.

PROFESSOR BRINDLEY; ASSOCIATE PROFESSORS VON TUNGELEN, RANKIN

SUBJECTS FOR GRADUATES AND ADVANCED UNDERGRADUATES

Problems in Advanced Agricultural Economics; Marketing of Agricultural Products; Rural Sociology; Business Economics; Public Utilities; Rural Law; Veterinary Law; Business Law; Accounting; Statistics; Household Accounting; Advanced Accounting; Principles of Applied Sociology; Rural Sociology. For descriptions of these subjects see page 191 in General Catalogue.

**Electrical Engineering**

Professor Fish; Associate Professors Bartholomew, Wright; Assistant Professors Robbins, Paine

The Department of Electrical Engineering offers opportunity for major work leading to the degree of Master of Science in Electrical Engineering. The subjects offered are advanced theory of alternating currents, electric power transmission, electric railways, and advanced work on the operating characteristics of electrical apparatus.

Opportunity for minor work is also given to those majoring in other departments of Engineering and in the departments of the Industrial Science and Agricultural Divisions.

SUBJECTS FOR GRADUATES

**1051. Electrical Engineering.** Advanced work in alternating currents, electric railway engineering, electric power transmission, telephony, wireless telegraphy, and characteristics of electrical machinery. Intensive, study of any one of these subjects is here made possible. Suitable major and minor work will be arranged to suit the needs of the student. Proper fees charged for laboratory work chosen.

PROFESSOR FISH; ASSOCIATE PROFESSORS BARTHOLOMEW, WRIGHT;  
ASSISTANT PROFESSORS ROBBINS, PAINÉ

SUBJECTS FOR GRADUATES AND ADVANCED UNDERGRADUATES

Principles of Electrical Engineering; Direct and Alternating Current Machinery; Seminars; Theory of Alternating Currents; Telephony; Electric Railways; Power Transmission; Telephone Engineering; Thesis. See page 200 in General Catalogue.

For the requirements for the professional degree of Electrical Engineer, see page 20.

**Farm Crops and Soils**

Professors Stevenson, Hughes, Brown; Associate Professors Smith, Potter; Chief Burnett

Graduate work in the department comprises investigations in the two general fields of soils and of farm crops. Major and minor work for the Master's degree is offered along the lines of crop production, crop breeding, soil physics, soil fertility, soil bacteriology, soil humus, and soil management. For the Doctor's degree, major and minor work is offered in soil fertility, soil bacteriology, and soil humus.

Research problems of great value to the state are carried on in each of the above lines by graduate students and members of the department faculty. Much interest is stimulated in such research by the meetings of the Iowa Section of the American Society of Agronomy which is composed of the graduate students of the department and the department faculty.

#### SUBJECTS FOR GRADUATES

30. **Research in Crop Production.** Problems of growth and the harvesting and storage of cereal crops. *Either Sem.* *Prerequisites 1, 2, 3, 33; credit 5 or 10 hrs.* PROFESSOR HUGHES

37. **Conferences in Crop Production.** Reports and discussion on current investigations. *Either Sem.* PROFESSOR HUGHES

131. **Research in Crop Breeding.** (a) Cereal Breeding. Special problems with the Iowa Experiment Station. (b) Forage Crop Breeding. The important crops, timothy, red clover, sweet clover, and alfalfa at the station nurseries. (c) Methods of Investigation. Special problems. *Either Sem.* *Prerequisites 137, 138, and 139; credit 5 or 10.* PROFESSOR HUGHES

142. **Conference in Crop Breeding.** Reports and discussion on current investigations. *Either Sem.* PROFESSOR HUGHES

130. **Research in Soil Physics.** Origin and classification of soils of definite areas with study of agricultural adaptation; physical characteristics of soils, with particular reference to moisture, temperature, mechanical analysis, and identification; methods of investigation, with reference to the determination of the physical properties of soils. *Either Sem.* *Prerequisite 121 or 141; credit 5 or 10; fee \$5.00.* PROFESSOR BROWN, ASSOCIATE PROFESSOR SMITH, ASSISTANT PROFESSOR EASTMAN

131. **Conference in Soil Physics.** Reports and discussion on current investigations. *Either Sem.* PROFESSOR BROWN.

231. **Research in Soil Bacteriology.** Same as Bact. 31. Bacterial activities in the soil. Field, greenhouse, or laboratory experiments. The classification of soil bacteria, molds, protozoa, and higher bacteria; occurrence and action in soils. General study of the relation of soil organisms to fertility. *Either Sem.* *Prerequisite 201; credit 5 or 10; fee \$5.00.* PROFESSOR BROWN

232. **Conference in Soil Bacteriology.** Same as Bact. 232. Reports and discussion on current investigations. *Either Sem.* PROFESSOR BROWN.

241. **Research in Soil Humus.** Organic material in soils looking to its classification; the rate of decomposition of organic matter in soils, correlation with the state of undecomposed matter, with micro-organisms, and with productivity. *Either Sem.* *Prerequisites 322 or 342 and 201; credit 5 or 10; fee \$5.00.* PROFESSOR BROWN, ASSOCIATE PROFESSOR POTTER

242. **Conferences in Soil Humus.** Reports and discussion on current investigations. *Either Sem.* ASSOCIATE PROFESSOR POTTER

332. **Research in Soil Fertility.** Special soils, with reference to the physical and chemical properties and deficiencies in plant food, with ex-

periments to test the efficiency of certain treatments; relationship between soil composition and crop production; value of fertilizing materials, as determined by pot and plot experiments. *Either Sem.* *Prerequisite 322 or 342; credit 5 or 10; fee \$5.00.*

PROFESSOR BROWN, ASSOCIATE PROFESSOR SMITH,  
ASSISTANT PROFESSOR BANCROFT

**333. Conferences in Soil Fertility.** Reports and discussion on current investigations. *Either Sem.* *PROFESSOR BROWN*

**438. Research in Soil Management.** The effects of certain systems of soil management; comparison of the past and present systems as shown by soil and crop conditions in different localities and under different conditions; systems of soil management under livestock, grain, mixed or truck systems of farming; management of special soils, including gumbo, peat, alkali, and others. *Either Sem.* *Prerequisites 121 or 141 and 322 or 342; credit 5 or 10.* *PROFESSOR STEVENSON*

**439. Conferences in Soil Management.** Reports and discussions on current investigations. *Either Sem.* *PROFESSOR STEVENSON*

#### SUBJECTS FOR GRADUATES AND ADVANCED UNDERGRADUATES

Corn Production; Small Grain Production; Small Grain and Forage Crops; Special Problems in Crop Production; Methods of Crop Investigations; Advanced Judging; Forage Crop Production; Fiber, Sugar, and Root Crops; Corn Breeding Small Grain Breeding; Forage Crop Breeding; Special Problems in Crop Breeding; Seminars; Soil Physics; Physics of Forest Soils; Forest Physiography and Soil Surveying; Special Problems in Soil Physics; Soil Bacteriology; Special and Advanced Problems in Soil Bacteriology; Special and Advanced Problems in Soil Fertility; Soil Fertility; Soil Management; Soil Surveying and Mapping; Special and Advanced Problems in Soil Surveying. For descriptions of these subjects see page 211 in the General Catalogue.

### Farm Management

Professor Munger; Assistant Chief Lloyd

Major and minor work for the Master's degree is offered in Farm Management. The problems which may be pursued include farm surveys, cost accounting, land tenure, and farm tenancy.

#### SUBJECTS FOR GRADUATES

**7. Research.** Original investigation of a special farm management problem. *Either Sem.* *PROFESSOR MUNGER; ASSISTANT CHIEF LLOYD*

#### SUBJECTS FOR GRADUATES AND ADVANCED UNDERGRADUATES

Farm Management; Advanced Farm Management; Research; Seminar. For descriptions see page 220, General Catalogue.

### Forestry

Professors Beach, MacDonald; Associate Professor Morbeck

The department offers major and minor work leading to the degree Master of Science in Forestry. Also a five-year outlined course, developed along the lines of forest protection, forest management, lumbering, and forest products, and leading to the same degree, is maintained for the

special benefit of students who, at the beginning of their Freshman year, decide to spend five years in the study of Forestry. Candidates for a higher degree, who are pursuing the five-year course, are subject to the rules and regulations of the Graduate Division during the fifth year of residence.

#### SUBJECTS FOR GRADUATES

**42. Advanced Forest Management.** Special Problems in regulation of yield in the forest. Construction of working plans. Assessment of damages to forest property. Field investigations and reports on forest lands within Iowa. *10th Sem.* *Prerequisite 9, 10, 11, 52; credit 3.*

PROFESSOR MACDONALD

**43. Advanced Forest Regeneration.** In connection with 42. Nursery methods, seeding and planting. The preparation of planting plans for specific areas. Methods of increasing forest productivity in native stands and plantations by artificial means. Field work given an important place. *10th Sem.* *Prerequisite 53; credit 2.*

PROFESSOR MACDONALD

**44. Forestry Research.** Special investigations chosen in conference with the Forestry faculty. *10th Sem.* *Credit 2 to 12.*

PROFESSOR MACDONALD

**45. Advanced Wood Structure.** Special investigation for advanced students in the structure of wood. *8th Sem.* *Prerequisite 59; credit 3.*

PROFESSOR MACDONALD

**46. Grading Lumber.** Origin and development of grading rules for lumber. Various rules employed in grading lumber in lumbering regions. The grading of by-products of lumber mills. *10th Sem.* *Prerequisites 36, 54; credit 1.*

ASSOCIATE PROFESSOR MORBECK

**47. Advanced Lumbering.** Special investigation in logging, milling, transportation, and marketing forest products. *10th Sem.* *Prerequisites 36, 54, and 55; credit 3.*

ASSOCIATE PROFESSOR MORBECK

**48. Advanced Forest Protection.** Injuries to forests, especially by fire. The preparation of fire plans. Timber protective associations and their work. The duty of the state toward the preservation and protection of the forests. *10th Sem.* *Prerequisite 11; recitations 3; credit 3.*

ASSOCIATE PROFESSOR MORBECK

#### SUBJECTS FOR GRADUATES AND ADVANCED UNDERGRADUATES

Advanced Forest Management; Advanced Forest Regeneration; Forestry Research; Wood Structure; Grading Lumber; Forest Protection; Forest Valuation; Timber Preservation; Municipal Forestry; Economic Woods; Silviculture; Lumbering; Forest Products; Forest Administration; Thesis; Seminar; State and National Forestry Laws; Wood Technology; Lumber Markets and Transportation. For description of these subjects see page 229 in General Catalogue.

### Geology

Professor Beyer; Assistant Professor Galpin

The department offers major and minor work for the Master's degree along those lines in which geology has an intimate relationship to mining engineering, soil formation, etc. The department also offers major work

for the degree of Doctor of Philosophy in the fields of economic geology and petrology.

#### SUBJECTS FOR GRADUATES

**25. Advanced Soils Geology.** *Work continued through 1 to 4 semesters. Credit 2 to 5 hrs. per semester as arranged. Fee \$1 to \$3 per semester.*

PROFESSOR BEYER

**26. Advanced Mining Geology.** *Work continued through 1 to 4 semesters. Credit 2 to 5 hrs. per semester as arranged.* PROFESSOR BEYER

#### SUBJECTS FOR GRADUATES AND ADVANCED UNDERGRADUATES

Advanced Geology; Economic Geology; Mineralogy; Meteorology and Climatology; Agricultural Geology; Invertebrate Paleontology; Vertebrate Paleontology and Paleo-Botany; Petrology; Optical and Physical Mineralogy; Petrography; Summer Field Work. For descriptions of these subjects see page 237 in General Catalogue.

### Home Economics

Professor MacKay; Associate Professors Gettemy, Monsch, Brandt, Fisher; Assistant Professors Humphrey, Olsen, Witwer, McNeal

Opportunities are offered for graduate study leading to the Master's degree in Home Economics. The major part of the graduate work is offered in the fields of chemistry, bacteriology, economic science, physiology, etc., which have special application to home economics. Each student, therefore, chooses her major graduate work in the particular field in which she wishes to specialize.

#### SUBJECTS FOR GRADUATES

**101. Nutrition Seminar.** Individual study of the recent advances in the science of nutrition with class reports and discussions upon assigned topics. *Hours to be arranged. Prerequisite, H. Ec. 46.*

ASSOCIATE PROFESSOR MONSCH

**110. Textile Research.** *Prerequisite 42.* MISS MURRAY

Graduate courses in Bacteriology, Chemistry, Physiology, or Economic Science, etc., as related to Home Economics may constitute the major. These subjects are described under the respective departments in the General Catalogue.

#### SUBJECTS FOR GRADUATES AND ADVANCED UNDERGRADUATES

Nutrition and Dietetics; Advanced Nutrition and Dietetics; Experimental Problems in Foods; House Practice; Training in Teaching Home Economics; Demonstrations; Applied Dress Design; Advanced Millinery; Pattern Research; Economic Clothing; Children's and Misses' Wardrobes; Costume Design; Textile Design; The House; History of Art-Painting; History of Art-Sculpture; History of Costume. For descriptions of these subjects see page 249 in the General Catalogue.

### Horticulture

Professor Beach; Chiefs Erwin, Greene; Associate Professors Culley, Harrington; Assistant Professor Thurston

The department offers major and minor work for the Master's degree along the lines of general horticulture, pomology, truck crops, landscape

gardening, and floriculture; and major and minor work for the Doctor's degree along the lines of plant breeding and pomology.

#### SUBJECTS FOR GRADUATES

58. **Thesis or Research.** Special topics for investigation for minor or major graduate work. *Hours by appointment.*

PROFESSOR BEACH; ASSOCIATE PROFESSOR CULLEY; CHIEFS ERWIN, GREENE

152. **Thesis or Research.** Special topics for investigation for major or minor graduate work. *Hours by appointment.*

PROFESSOR BEACH; ASSOCIATE PROFESSOR HARRINGTON; CHIEF GREENE

252. **Thesis or Research.** Special topics for investigation for major or minor graduate work. *Hours by appointment.*

ASSISTANT PROFESSOR THURSTON; CHIEF ERWIN

352. **Thesis or Research.** Special topics for investigation for major or minor graduate work. *Hours by appointment.*

ASSISTANT PROFESSOR THURSTON; CHIEF ERWIN

452. **Thesis.** Special topics for investigation for major or minor graduate work. *Hours by appointment.* ASSOCIATE PROFESSOR CULLEY

#### SUBJECTS FOR GRADUATES AND ADVANCED UNDERGRADUATES

Plant Genetics; Markets and Marketing; Plant Breeding; Fruit Farm Management; Advanced Pomology; Greenhouse Management; Market Gardening; Truck Farm Management; History of Landscape Gardening; City Planning; Maintenance and Construction; Shade and Street Tree Management; Landscape Design; Civic Design; Planting Plans. For descriptions of these subjects see page 264 in the General Catalogue.

### Mathematics

Professors Stanton, Roberts; Associate Professors Colpitts, Pattengill, Chaney, Snedecor; Dr. Tappan

Major and minor work for the degree of Master of Science is offered by the department. Special courses in advanced mathematics of engineering, physics, economic problems, statistics, and biological problems are so correlated with the technical lines of work as to demand consideration of all students who expect to teach applied mathematics in technical institutions or to become investigators in any of the above lines of work.

#### SUBJECTS FOR GRADUATES

55. **The Theory of Functions of the Complex Variable.** Introductory. Complex numbers and their geometrical representations; conformal representation, and analytic functions of a complex variable. *5th, 6th, 7th, or 8th Sem. Lectures and recitations 3, or throughout the year; credit 3 to 6.* ASSOCIATE PROFESSOR COLPITTS

77. **Advanced Dynamics.** Critical treatment of the laws of motion, particular motions of a material point, work and energy; principle of least action; generalized equations of motion; dynamics of rigid, rotating, and deformable bodies; the theory of potential and hydrodynamics. *Prerequisites 58, 73; lectures and recitations 3 or throughout the year; credit 3 to 6.* ASSOCIATE PROFESSOR CHANEY

**79. Differential Equations of Mathematical Physics.** A critical treatment of the equations of Bessel, Laplace, Poisson, Legendre, Fourier, and of Lagrange's equations of motion, with application to certain boundary value problems of physics. *Prerequisite 58; lectures and recitations 3; credit 3.*

ASSOCIATE PROFESSOR CHANEY

**82. Introduction to the Mathematical Theory of Electricity and Magnetism.** A treatment of electrostatics and current electricity, magnetostatics and electrodynamics from the mathematical standpoint. *Prerequisites 58, 73; 3 hours for one semester, or 2 hours for the year; credit 3 or 4.*

ASSOCIATE PROFESSOR CHANEY

#### SUBJECTS FOR GRADUATES AND ADVANCED UNDERGRADUATES

Theory of Equations; Determinants and Advanced Analytic Geometry; Advanced Spherical Trigonometry; History of Mathematics; Advanced Differential and Integral Calculus; Differential Equations; Projective Geometry; Higher Algebra; Infinite Series; Mathematical Theory of Statistics; Mathematics as Applied to Economic Problems; Theoretical Mechanics; Theory and Applications of Vector Analysis. For descriptions of these subjects see page 279 in the General Catalogue.

### Mechanical Engineering

Professor Meeker; Associate Professors Cleghorn, Major, Norman, Leavell

The department offers major work for the degree of Master of Science in Mechanical Engineering along the lines of gas engineering, steam engineering, heating and ventilation, machine designing, railway mechanical engineering, automobile engineering; and minor and supporting work in the other departments of the Engineering, Agricultural, and Industrial Science Divisions.

#### SUBJECTS FOR GRADUATES

**1051. Railway Mechanical Engineering.** Special advanced studies in car construction and design; study of design and operation of air brakes, together with theory of braking and the application to operation of trains; locomotive design, operation, and tests; railway shop design and management; railway hydraulic and pneumatic machinery; and special independent research of the many problems of railway mechanical engineering. The completion and equipment of the Transportation Building, with its locomotive testing laboratory, affords excellent opportunities for advanced research and graduate study along this important line. The Chicago and Northwestern Railway Company is coöperating fully with the College in work of this nature. *Open for major or minor subjects. Fees for laboratory work will be specially arranged.*

PROFESSORS MEEKER, NORMAN, CLEGHORN

#### SUBJECTS FOR GRADUATES AND ADVANCED UNDERGRADUATES

Mechanics of Engineering; Hydraulics; Heating Design; Machine Work; Seminars; Machine Design; Steam Engines and Boilers; Power Plant Engineering; Steam and Gas Laboratory; Crane Design; Gas Engine Construction and Operation; Gas Engine Design; Power Engineering. For descriptions see page 293 in General Catalogue..

For the requirements for the professional degree of Mechanical Engineering, see page 20.

### Mining Engineering

Professor Beyer; Associate Professor Hodson

All of the subjects offered are required of undergraduates who specialize in Mining Engineering and Metallurgy, but may be elected for minor work by graduates who are majoring along other lines. The department does not, at the present time, offer major work for an advanced degree.

#### SUBJECTS FOR GRADUATES AND ADVANCED UNDERGRADUATES

Principles of Mining; Metallurgy; Mining Engineering; Advanced Metallurgy; Mine Administration; Mining Law; Seminar. For descriptions of these subjects see page 308 in General Catalogue. For the requirements of the professional degree of Mining Engineer see page 20.

### Physics

Professor Spinney; Associate Professors Stiles, Thompson, Kunerth; Assistant Professor Plagge

The Department of Physics offers major and minor work leading to the degree of Master of Science in those fields of physics which are related to industrial science, engineering, home economics, and agriculture.

#### SUBJECTS FOR GRADUATES

1041. Theory of Heat.
1042. Wave Motion and Sound.
1043. Theory of Light.
1044. Theory of Electricity and Magnetism.
1045. Research.
1046. Research.
1047. Physics Seminar.

#### SUBJECTS FOR GRADUATES AND ADVANCED UNDERGRADUATES

Physical Laboratory; Sound; Advanced Physical Laboratory; Advanced Course in Heat; Advanced Course in Light; Industrial Physics; Theory of Illumination; Photography; Methods of Observation and Theory of Measurements; Wave Motion and Sound; Electricity and Magnetism; Electron Theory and Radio Activity; History of Physics; Theory of Illumination; Thesis. For description of these subjects see page 321 in General Catalogue.

### Veterinary Anatomy

PROFESSOR HOWARD SYLVESTER MURPHEY

Major and minor work for the degree of Master of Science is offered by the department in histology and in gross anatomy. Minor work in anatomy is suggested for students majoring in animal nutrition, biological chemistry, pathology, physiology, and zoology.

#### SUBJECTS FOR GRADUATES

1010. Research in Anatomy. Problems of importance relative to Animal Husbandry, Veterinary Physiology, Pathology, or Surgery. Anatomical problems of a systemic, topographic, or comparative nature. *Lab. 3 or 4; credit 3 or 4.*

PROFESSOR MURPHEY

**1011. Research in Microscopic Anatomy.** Physiological histology; comparative work dealing with problems of importance to pathology, or with anatomical problems relating to histogenesis or morphology.

PROFESSOR MURPHEY

SUBJECTS FOR GRADUATES AND ADVANCED UNDERGRADUATES

Osteology and Arthrology; Myology and Splanchnology of the Horse; Myology, Angiology, Neurology; Comparative Anatomy; Microscopy and Microscopic Anatomy; Microscopic Anatomy of the Organs of the Domestic Animals; Applied Topographic (Surgical and Clinical) Anatomy. For descriptions see page 330 in General Catalogue.

NOTE: 101, 202, 303, 404, 133, and 234 are offered as graduate subjects to Animal Husbandry and Industrial Science students.

**Veterinary Pathology and Bacteriology**

Professor Dimock; Associate Professor Murray

The department offers major and minor work leading to the Master's degree along the lines of systemic pathology, the pathology of specific infectious diseases, the pathology of sporadic diseases, tumors, chemical pathology, veterinary bacteriology, immunity and serum therapy.

Students who major in veterinary bacteriology including immunity and serum therapy will classify with the Department of Bacteriology in the Industrial Science Division, but will do their work in the Department of Veterinary Pathology and Bacteriology. Students who major in pathology will classify in the Department of Veterinary Pathology and Bacteriology.

SUBJECTS FOR GRADUATES

**1020. Research in Pathology.** (a) Systemic pathology. (b) The pathology of specific infectious diseases. (c) The pathology of sporadic diseases. (d) Tumors. (e) Chemical pathology. *Prerequisites 350 and 536 or their equivalent.*

PROFESSOR DIMOCK

**1025. Research in Bacteriology.** (a) Veterinary bacteriology. (b) Immunity. (c) Serum therapy. *Prerequisite 350 or its equivalent.*

ASSOCIATE PROFESSOR MURRAY

SUBJECTS FOR GRADUATES AND ADVANCED UNDERGRADUATES

General Pathology; Special Pathology; Advanced Pathology; Immunity and Serum Therapy; Laboratory in Immunity and Serum Therapy; Milk Hygiene. For descriptions see page 333 in General Catalogue.

**Veterinary Physiology and Pharmacology**

Professor Henry Dale Bergman

The department offers major work for the Master's degree along lines of investigation of physiological subjects relative to veterinary science; and minor and supporting work in physiology for graduate students in the Industrial Science Division or for agricultural students who are doing their major work along such lines as general nutrition, production problems, feeding, breeding, etc.

Students who major in physiology for an advanced degree must have

had such previous training in physiology, and related subjects, such as anatomy, histology, chemistry, etc., as will permit of advanced study.

#### SUBJECTS FOR GRADUATES

**1001. Comparative Physiology.** Minor graduate work especially arranged to meet the needs of graduate students in agriculture, doing their major work along such lines as general nutrition, meat or milk production problems, animal feeding, breeding, etc. The work may be selected and the laboratory and time requirements arranged by consultation with the head of the department. *1st Sem.* PROFESSOR BERGMAN

**1002. Comparative Physiology.** Continuation of 1001, including considerable individual conference work, and biweekly meetings of graduate students to discuss especially assigned topics. *2nd Sem.* PROFESSOR BERGMAN

**1005. Research in Physiology.** An opportunity for investigation work in physiological subjects relative to veterinary science is offered to a limited number of students who have had such prerequisite work as may be essential to its pursuance. The selection of work and the amount of time required are arranged, in each case, by consultation with the head of the department. PROFESSOR BERGMAN

#### SUBJECTS FOR GRADUATES AND ADVANCED UNDERGRADUATES

Comparative Physiology; Advanced Comparative Physiology; Seminar. For descriptions of these subjects see page 335 in General Catalogue.

### Zoology

Professor Summers; Associate Professors Guthrie, Bartholomew, Ewing,  
Assistant Professors Harrison, Scullen

The department offers major and minor work for the Master's degree along the lines of entomology, comparative physiology, invertebrate and vertebrate comparative anatomy; and major work for the Doctor's degree along the lines of entomology and comparative physiology.

#### SUBJECTS FOR GRADUATES

**64. Research in Zoology.** Investigation in some zoological subject suitable for a thesis. The prerequisites and the selection of the work and the amount of time required will be in each case determined by consultation with the head of the department. *Both Sems. Deposit \$3.00.* ASSOCIATE PROFESSOR GUTHRIE

**151. Research in Physiology.** Investigations in some physiological subject suitable for a thesis. The prerequisites and the selection of work and the amount of time required will be determined in each case by consultation with person in charge of work. *Both Sems. Fee \$3.00.* ASSISTANT PROFESSOR SCULLEN

**248. Research in Embryology.** Investigation of some problems in development suitable for presentation as a thesis. The prerequisites and

the selection of work and the amount of time required will be determined in each case by consultation with the head of the department.

ASSOCIATE PROFESSOR GUTHRIE

356. **Advanced Research in Entomology.** Preparation of master's thesis in entomology or parasitology. *Both Sems. Prerequisite 355; labs. time arranged; credit according to lab. schedule; deposit \$5.00.*

ASSOCIATE PROFESSOR EWING

#### SUBJECTS FOR GRADUATES AND ADVANCED UNDERGRADUATES

Evolution of Animals; Vertebrate Comparative Anatomy; Morphology; Advanced Invertebrate Comparative Anatomy; Advanced Entomology; Neurology; Economic Entomology; Orchard and Nursery Inspection; Literature of Entomology; Comparative Physiology, and Embryology; Elementary Research in Entomology; Advanced Research in Entomology; Greenhouse and Truck Crop Pests; Histology and Histological Technique. For descriptions see page 344 in General Catalogue.

### DEPARTMENTS OFFERING MINOR WORK ONLY

The work in the following departments is undergraduate in character and is subordinate and auxiliary to the work of the departments which offer major lines.

#### History

Professor Cessna; Associate Professor Schmidt; Instructor Arragon

Students majoring for advanced degrees in agriculture or industrial science or applied economics and social science may minor in history. The chief purpose of this work is to furnish an historical foundation for the study of the present day economic and social problems in technical fields. The new trend in historical science has brought the study of history into a very fundamental relation to the industrial sciences.

#### SUBJECTS FOR GRADUATES

50. **Economic History of the United States, 1860-1880.** Economic causes, problems, and effects of the Civil War; the public lands; agriculture, manufacturing, and mining; internal trade and transportation; foreign commerce and shipping; banking, currency, and tariff legislation; and foreign complications. Special attention given to the history of the Granger movement in its economic and political aspects. *7th Sem. Recitations 3; credit 3.*

ASSOCIATE PROFESSOR SCHMIDT

76. **Economic History of Agriculture in Iowa.** Economic resources; early trade and exploration; Indian tribes and land cessions; pioneer population and agriculture; growth of markets; transportation; development of specialized and diversified farming; land tenure; agricultural labor; use of improved farm machinery. Attention also given to the sources of immigration; the type of farmers; methods of agriculture; currency and banking; relation of the farming class to national monetary legislation and the tariff; the relation of the State to agriculture; and an historical and comparative analysis of present day agrarian problems. *9th Sem. Recitations 2; credit 2.*

ASSOCIATE PROFESSOR SCHMIDT

98. **Research in Economic History.** 9th or 10 Sem. Credit 2 to 6 hours. ASSOCIATE PROFESSOR SCHMIDT; INSTRUCTOR ARRAGON

SUBJECTS FOR GRADUATES AND ADVANCED UNDERGRADUATES

Economic History of American Agriculture; History of the United States as a World Power; Tariff History of the United States; Economic History of Modern Europe; Economic History of English Agriculture; History of Labor Problems in the United States; History of Domestic Commerce; Comparative European Government; American Government and Politics. For descriptions of these subjects see page 240 in General Catalogue.

**Psychology**

Professor Cessna; Associate Professor Vance

Students majoring for advanced degrees in agriculture or industrial science or applied economics and social science may minor in psychology. It is evident that all subjects involving the human element must be based on the knowledge of the laws of mental action. The study of psychology is regarded as necessary to the proper understanding of such problems as industrial development and efficiency, rural social uplift, etc.

SUBJECTS FOR GRADUATES AND ADVANCED UNDERGRADUATES

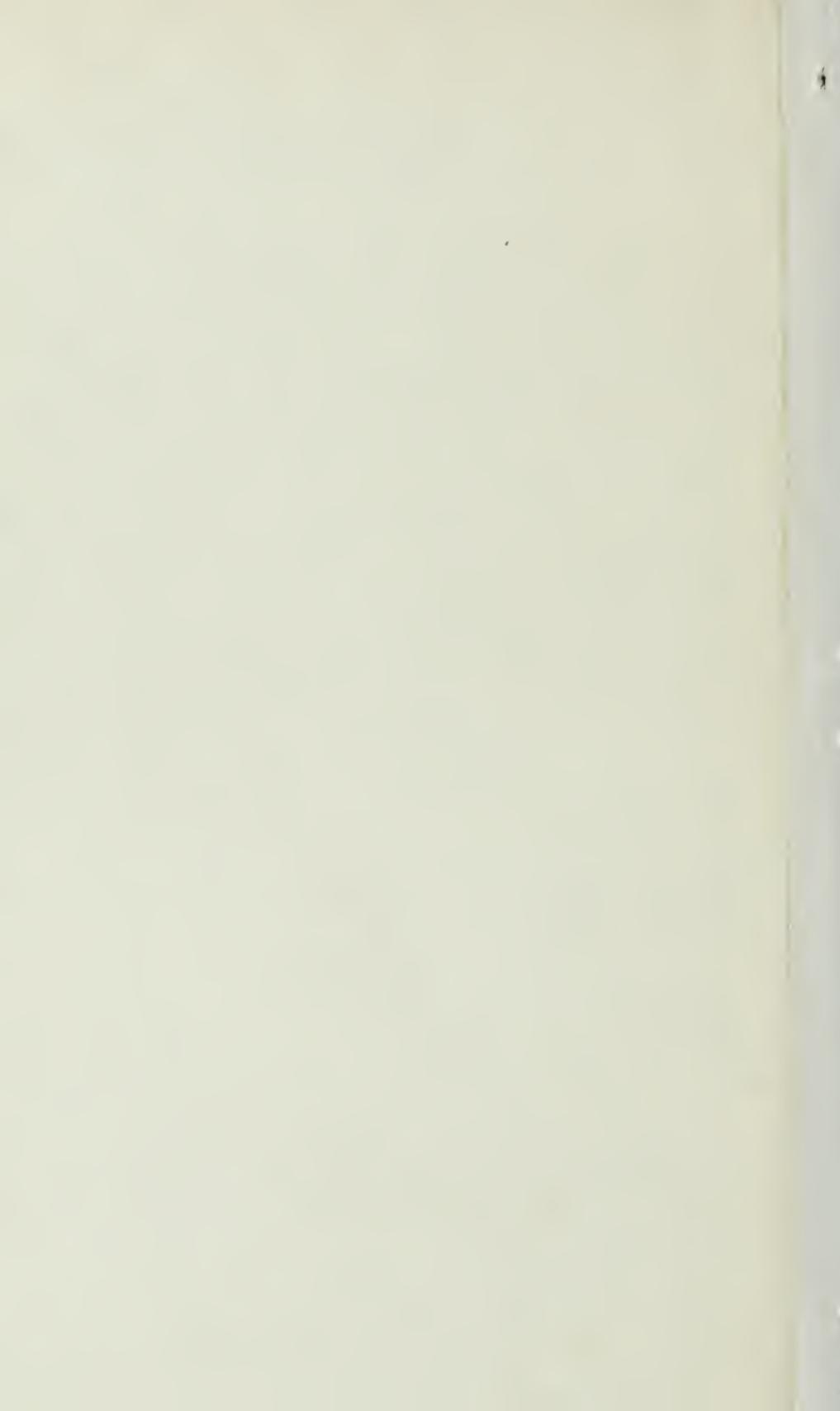
Ethics; Social Psychology; Psychology of Business; The Animal Mind; Social and Ethical Institutions of Bible Times; Social and Ethical Teachings of Jesus. Psychology of Childhood and Adolescence; Educational Psychology. For descriptions of these subjects see page 324 in the General Catalogue.

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